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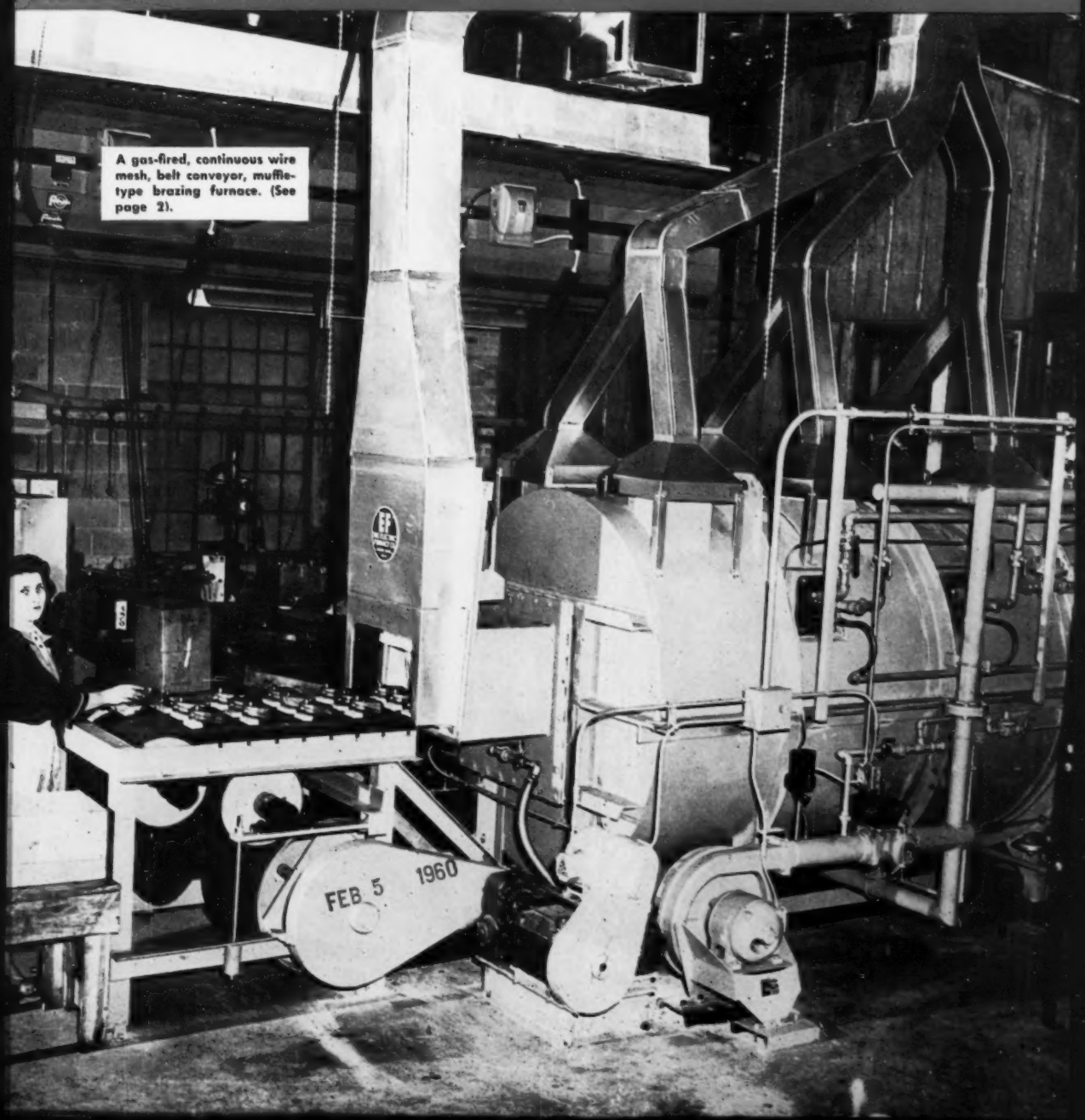
Metal Treating

THE *ONLY* MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY



A gas-fired, continuous wire mesh, belt conveyor, muffle-type brazing furnace. (See page 2).

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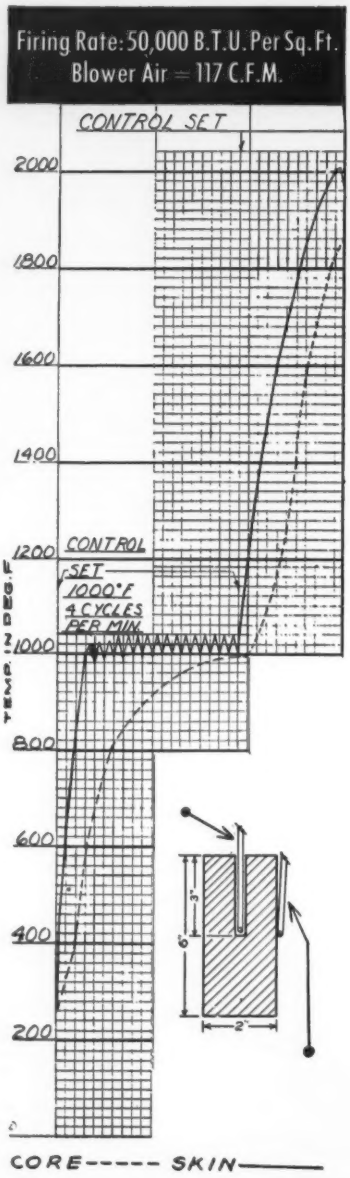

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Indexed in Engineering Index

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BRAZING-

INDEFINITELY INDISPENSABLE

By **P. D. JOHNSON,** Assistant Technical Director
The Glidden Company
Chemicals—Pigments—Metals Division
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Introduction

Joining processes of many descriptions are a significant part of everyday life. Sealing an envelope, applying a postage stamp to a letter and securing papers with a clip are but a few examples that could be cited. Today, the emphasis is upon "do-it-yourself" with nailing, gluing, tacking, painting, etc., very commonplace practices in most homes. In each case, two or more parts are connected to form a finished article, thus comparing with metal joining, whether it be soldering, brazing or welding. Although the average person lacks familiarity with metal bonding processes in general, they are nonetheless indispensable to modern civilization.

Our primary concern shall be with brazing, but first it is well to consider its differentiation from soldering and welding. *Table I* presents in concise form a comparison of these fundamental methods of joining. If practical, comments regarding comparative joint strengths would have been included.

Joint quality is a function of many variables — such as the skill of the operator, joint design, type of process, character of filler and parent metals, etc. Usually, soft solder joints are the weakest because of the low strength properties of the filler metals and very shallow alloying at joint interfaces afforded by low operating temperatures. Most suitable end uses involve parts not subjected to repeated shock, vibrations, tensional or torsional forces. Radio and television applications are, therefore, quite ideal. In contrast, brazed joint strengths are usually appreciably greater because of more significant joint interface alloying and the mechanical properties of resultant alloys. Welded joints also may have exceptional strength properties deriving from fusion between filler and base metals.

Present Brazing Practices

Joining processes in America have come a long way since Columbus beached the Santa Maria on the shores of the West Indies in 1492. Relics of earlier times indicate that Indians formed articles of innumerable descriptions from powdered metals, particularly copper, gold and platinum. Metallic particles apparently were compressed into desired shapes and subsequent heating effected reasonably adequate but not too substantial bonding. It was not until much more

TABLE I

	PROCESSES	OPERATING TEMPERATURES	CHARACTER OF BRAZE
Brazing	Dip Furnace Induction Resistance Salt Bath Torch Vacuum	Below melting point of parent metal. Greater than 800°F.	Intermediate alloying at joint interface due to diffusion and solvent effect of molten filler metal on parent metal.
Bronze Welding	Arc Torch	Below melting point of parent metal. Usually 1450-1650°F.	
Autogenous Welding	Arc Resistance Torch	Melting point of parent metal.	Extreme alloying at joint interface due to melting of both filler and parent metals.
Soft Soldering	Dip Furnace Induction Torch	Below melting point of parent metal. Usually less than 800°F.	Minimum alloying at joint interface due to diffusion and solvent effect of molten filler metal on parent metal.

recently that the true principles of metal joining were discovered.

Several methods evolved and in the course of time were refined as the metallurgical principles of brazing came into clearer focus. In their development, two basic questions had to be answered. First, what are the requirements of an acceptably brazed joint? Secondly, how can it be accomplished? In a very general sense, it was determined that satisfactory results occur when joint properties are comparable to the original state of the parent metal. Suitable methods must join the separate components of a part so that:

1. The joint area is totally displaced by the filler metal and sufficient alloying develops at the interfaces to assure some degree of parent metal diffusion through the cross-section;
2. The properties of the joint are sufficient to withstand the various forces, corrosion and heat to which the part will be finally subjected;
3. The ultimate physical and chemical properties of the total part compart favorably to the original base metal.

Attention is called to Fig. 1 illustrating a good brazed butt-joint in contrast to various defects responsible for unacceptable results. 1 (a) represents an ideal joint. The areas A-B and C-D indicate the depth of filler metal penetration into the parent metal parts. These magnitudes are arbitrarily drawn and are to be considered as nearly perfect only for comparative purposes with the other figures. B-C is the original joint area and note that it is now a totally metallic phase, free of voids. More specifically, suppose that our part consists of common or low carbon steel. Joint clearance, that is the distance B-C is .001 inch or less. Copper or copper oxide in various forms is applied at the top of the joint and the part is furnace brazed in the same position as the cross-sectional drawing. When the melting point of copper (1987°F.) is reached in the heat zone of the furnace, capillary attraction pulls it into the joint interface. After the brazing cycle is completed, the area A-D although infinitesimally small may be thought of as a continuously variable alloy, the copper concentration approaching 0% at the cross-sections A and D and attaining a maximum copper-rich copper-iron alloy composition at the center of area B-C.

Figure 1 (b) is identical to 1 (a) except that alloying at joint interfaces as determined by the areas E-F and G-H is obviously substantially less than in the case of 1 (a). This may result from insufficient brazing time where the filler metal was not in contact with the parent metal surfaces long enough at molten temperatures. This condition may also derive from incompatability of filler and parent metal, indicating that mutal wetting was not effected or the solubility of one metal in the other was relatively insignificant throughout the brazing temperature range. In either case, if the part were subjected to rupturing forces, tearing would be noted at the bonding surfaces or through the filler metal area F-G.

Again, Figure 1 (c) is similar to 1 (a) but the depth of alloying as indicated by areas I-J and K-L are perceptibly greater. This condition develops from a high degree of mutal solubility between filler and base metal at some temperature range during the brazing process and gives rise to distortions and severely altered chemical and mechanical properties.

Finally, Figure 1 (d) shows discontinuities at joint interfaces and voids in the filler metal displacement area N-O. The former condition may result from oxidized surfaces or, when used, entrapped fluxes. In furnace brazing of common steel with copper it is usually contended that fluxes are not essential. However, on some parts where large surfaces must be joined it cannot be expected that furnace atmospheres will penetrate remote areas and remove all residual oxides. Much more satisfactory results are secured by judicious use of a proper flux (less than 1% of a borax-boric acid flux by weight in terms of copper filler metal applied is usually very satisfactory). Entrapped fluxes often result if they are excessively active, undergoing substantial composition changes thus

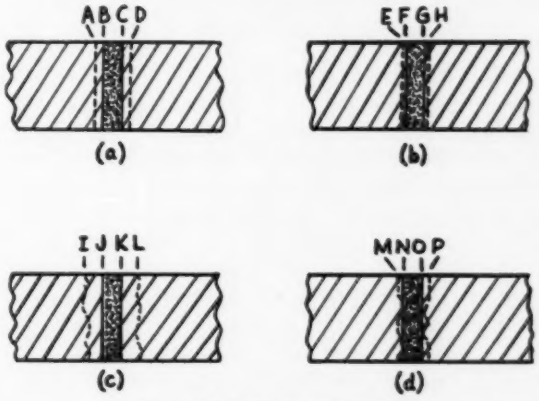

Fig. 1—Qualitative joint comparisons.

solidifying in joint areas even at the highest operating temperatures. Voids are likely to occur in the area N-O if the gap spatial distances are non-uniform with the filler metal following joint surfaces in the enlarged areas and, in turn, entrapping a gas bubble upon solidification.

Frequently, we read that the strength of copper-brazed joints in steel often exceeds that of the original metal. This derives from tensile strength improvement in steel through alloying with copper (up to 3%). For example, the tensile strength of normalized .02% carbon steel containing 0% copper averages about 48,000 PSI, whereas the same base metal containing 3% copper will attain a tensile strength of about 76,000 PSI.

The question may be raised, what is the ideal joint clearance? No single answer can be given, although prime considerations are:

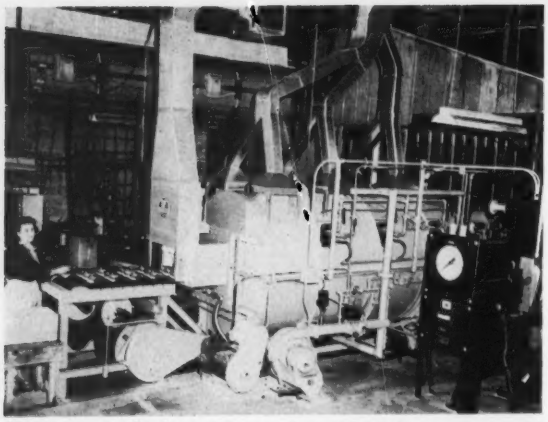

Fig. 2—A gas-fired, continuous wire mesh, belt conveyor, muffle-type brazing furnace. Available in various sizes for brazing, sintering and other processes at temperatures up to 2050°F. Courtesy of Electric Furnace Company, Salem, Ohio.

1. The surface tension and viscosity of the filler metal and the alloys it forms in joint interfaces at brazing temperatures.
2. Possible joint surface temperature differentials resulting from part design features and heating methods employed.

Regarding the first point, we are all familiar with the way water will rise in a small glass tube open at both ends when one end is immersed below the surface. The equation for the surface tension shows that it is proportional to the product of the internal radius of the tube and the height to which the liquid rises in the tube. Then for any given liquid at a fixed temperature, this product must be a constant. It readily follows that as the radius decreases, the liquid level in the tube must increase. Copper and the alloy it forms with iron exerts a very high surface tension at temperatures just above its melting point. Therefore, very tight joints are desirable in the copper brazing of steel, particularly on parts having large interfacial areas.

There is another force operating in opposition to the effects of surface tension. It is called "viscosity" and is the resistance experienced by one portion of a liquid in moving over another. A highly viscous liquid will not readily penetrate a very narrow area, although it eventally may if sufficient time is allowed. Many brazing operations, like induction joining for example, depend upon a quick flow of filler metal, and employ comparatively viscous filler metals. Therefore, joint clearances must be several thousands of an inch to assure filler metal joint penetration.

This brings us to our other point regarding joint clearances, particularly as they relate to the method of heating. Consider the brazing of a cylinder to a circumventing ring by an external induction coil. More rapid heating is effected in the ring which is normally compensated for by a tighter than usual fit. In contrast, suppose the heating is accomplished by an internal coil. Here the cylinder is more quickly heated and original gap clearances must be greater than usual. Summarizing, joint clearances must be determined by a complex interplay of various factors with best operations dependent upon converting as many of the variables to constants as possible.

Space considerations do not permit an evaluation of the various types of brazing equipment, fluxes and atmospheres capable of yielding the results just described. However, the accompanying photographs illustrate important types of equipment.

A Look To The Future

What will we look for in new brazing alloys and fluxes? Are sufficient knowledge and means at our disposal for effecting these developments? Discoveries of this nature may prove as illusive as the proverbial needle in the haystack or the pot of gold at the end of the rainbow. However, a reasonable assumption is that intensive research will evolve new joining media and compatible fluxes. The amount of trial and error experimentation will diminish in proportion to the understanding of atomic forces which give rise to the properties sought. Our purpose in this concluding section will be two-fold: first, to set down the desirable properties of brazing media and fluxes; and secondly, to consider very briefly some aspects of metal theory as related to the problem.

Brazing Media

The properties of an ideally brazed joint have been considered in some detail. It was stated that the total part, following brazing operations, should have metallurgical properties closely approximating the original unmated components. By implication, ductility is then a prime consideration since most metals used in fabricated parts demonstrate this property. It is for this precise reason that phos-copper cannot be used in steel joining, as brittle iron-phosphide forms in the crystal lattices. The problem then is complicated because ductility must not be evaluated in terms of brazing media composition but rather should anticipate alloy properties formed in interfacial areas.

Fig. 3—Discharging end of a continuous roller hearth type furnace used for copper brazing fittings into domes for hermetically sealed compressors.
Courtesy of Electric Furnace Company, Salem, Ohio.

Most of the new heat resistant brazing alloys incorporating silicon or boron are quite brittle but subsequent alloying during brazing results in substantially altered properties and adequate ductility.

In general, an alloy having ductility consists predominantly of various solid solution phases, both intersticial and substitutional, and, perhaps, aggregate insolubles with a minimum amount of intermetallic compounds. The hardness and consequent strength of solid solutions in a binary alloy increase steadily until there is approximately 50 atomic per cent of each component. (This physical phenomenon is well-illustrated by copper-nickel alloys having complete solid solubility in each other.) It is then quite apparent that solid solutions not only contribute to ductility but also distinctly relate to high joint strength properties. On the other hand, a brazing metal which to all appearances is formulated of solid solution alloys and insoluble aggregates only may be extremely brittle.

These undesirable qualities are frequently caused by minute quantities of a substance forming envelopes at grain boundaries thereby destroying crystal bonding. A dramatic example of this effect is characterized by 0.10% sulfur additions to pure nickel. If the sulfur is uniformly dispersed throughout the alloy, the nickel is rendered completely brittle by formation of a most detrimental constituent, the so-called intermetallic compound which is somewhat akin to the more familiar ionic compounds of chemistry. Their definite valence electron atom ratios are responsible for the formation of homopolar bonds and consequent brittleness. In a limited number of cases, judicious additions of specific metallic compounds have made rather brittle alloys somewhat more ductile probably through formation of intersticial solid solutions. This is indeed the exception and not the rule.

Fluidity, a rather ambiguous term, is a significant brazing media characteristic. The fluidity of any liquid is a function of surface tension and viscosity. Capillarity, or the ability of a brazing metal to penetrate narrow joint areas, is proportional to the surface tension. The rate at which the liquid flows is inversely proportional to its viscosity. Therefore, surface tension determines the ability of a filler metal to penetrate a prescribed deoxidized joint area and viscosity the time required to effect total distribution. (One cannot assign fixed values to these properties as they must be determined by specific job requirements.) To illustrate, an alloy tailored to join a large tight fit interface utilizing quick heating methods should exert a high degree of surface tension and low viscosity during joint alloying at brazing temperatures.

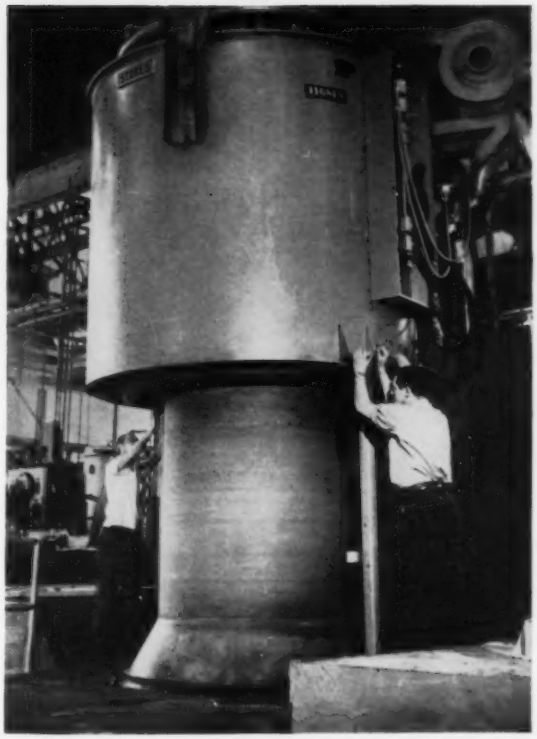

Fig. 5—Jet engine components are vacuum brazed in this furnace. The furnace shell containing the heating element is lowered over the retort which encloses the work. Courtesy of F. J. Stokes Corporation, Philadelphia, Pennsylvania.

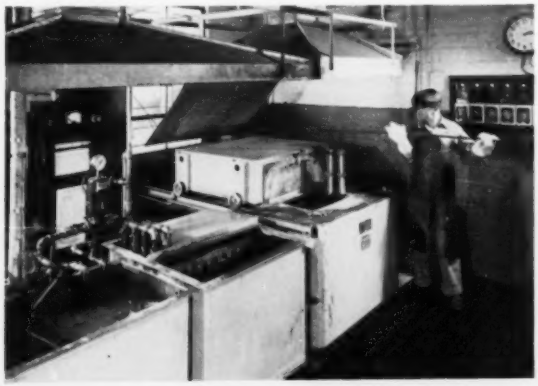

Fig. 4—Charge of rotary solenoid cases is about to be immersed in Ajax salt bath furnace for carburizing treatment. This furnace is capable of performing three jobs—simultaneous brazing and carburizing, brazing, and hardening.

Low vapor pressure joining media are preferred because they assure uniform joint properties. They are virtually required in furnace brazing where elements may be damaged by excessive metal volatility deriving from long heating cycles. (60-40 brass and most silver solders, for example, are generally restricted to fast heating processes like induction joining or salt bath brazing where metal distillation is depressed by pressure exerted by the molten salt.)

The degree of oxidation susceptibility of joining media is a vital factor and accounts for the extensive use of easily reduced copper in furnace joining. Brazing metals, easily prevented from oxidizing, do not impose rigid furnace atmosphere requirements and minimize flux usage in torch and induction joining techniques. Others, like phos-copper and heat-resis-

(*Continued on page* 49)

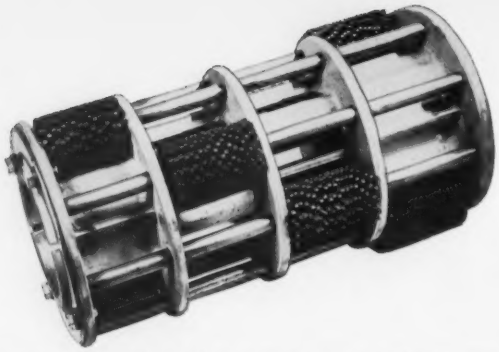

FIGURE 1: Scarifying tool used on Tennant floor-cleaning machines. Dual heat treated rods (supporting loosely mounted cutters) must withstand extremely severe shock and abrasion. Above tool revolves at 1750 rpm and covers a 16" path. Cutter spacing and arrangement depends on the application. All parts of these tools are heat treated one way or another. Special heat treating method for the rods is described in this article.

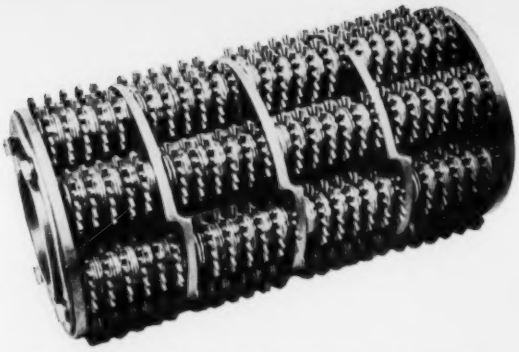

FIGURE 2: Close pattern scarifying tool is used for removing thick, hard layers of incrusted soilage from floors. By changing cutter type and spacing the tool can be adapted for many operations.

CASE HARDENING "HARDENED" RODS

By **Dr. ANDREAS LUKSCH,** Manager

Product Research and Development

G. H. Tennant Company

Minneapolis, Minnesota

and

PAUL B. WALLACE, Plant Metallurgist

Metallurgical, Incorporated

Minneapolis, Minnesota

FIGURE 6: Shows a typical example of the uniformity of the "case" produced on the heat-treated SAE 4150 rod.

TO PRODUCE a part that combines high surface hardness and abrasion resistance with extreme toughness, the G. H. Tennant Company of Minneapolis uses two separate heat treating cycles.

The part involved is a rod used in a heavy duty scarifying tool developed by the G. H. Tennant Company. The tool (a cutter-equipped rotating cylinder) is used to remove packed soilage from factory floors, to dress down or roughen concrete surfaces, to remove gravel from industrial roofs, and similar tough applications.

The tools are from 8" to 36" in length and cutters are spaced or arranged in various patterns (see Figures 1 and 2). The action of the tool is similar to a hammer

FIGURE 3: Floor machine uses a 21" wide scarifying tool for removing hard-packed buildup from aisles like this. Operator rides on rear platform and regulates tool-pressure and machine speed by use of hydraulic controls.

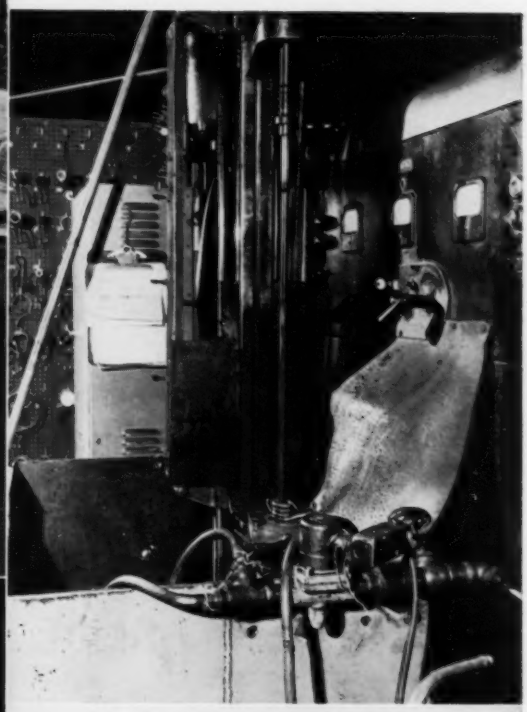

FIGURE 4: Toccotrol set-up with Lindberg 25 KW Induction Machine at the Metallurgical, Incorporated, Minneapolis plant. A four turn copper coil is used to uniformly heat the rod. A special quenching block follows the heating coil to immediately spray quench the rod. No tempering is required. No straightening is necessary. The hardened rod is within .010 TIR on lengths of 8" to 36".

FIGURE 5: Shows strength of the finished rod and illustrates case hardness and core toughness.

mill with the cutters riding loosely on the rods. Thus, both high impact and abrasion act on the rods. One of the machines using such a tool is shown in Figure 3.

After trying out various other approaches, the method used to produce the desired properties involves two separate heat treating cycles. The first is the conventional heat treatment done at the steel mill producing a cold drawn SAE 4150, 9/16 diameter bar with a RC hardness of 30 to 33. The basic heat treatment meets the first essential—high impact and tensile strength. To produce a high hardness at the surface, the finished machined rods are then subjected to an induction hardening process on a progressive Toccotrol set-up using a 25 KW Lindberg Induction Machine (Figure 4). This work was done by Metallurgical, Incorporated, of Minneapolis. The result is a "case hardened" rod of very high surface hardness and extreme core toughness.

To illustrate the combination of mechanical properties developed, Figure 5 shows two rods which were bent in a press brake. While the very hard case cracks in bending, the core is so tough that the rod will not break apart even though the crack has progressed through most of the section. One of the most important aspects of the progressive induction method of "case hardening" is that it produces a minimum of distortion. It is particularly well-suited for long, thin rods. A photo-micrograph of a section through the finished part is shown in Figure 6.

The method used is a good example of how the design engineer, the steel mill, and the heat treater can work together to produce a desired result. It may serve as a guide to designers who have to design for similar requirements. • • •

SALT BATHS AND SALT BATH FURNACES

By **HAIG SOLAKIAN, Sc. D.,** President
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Branford, Connecticut

Editor's Note: *This is the concluding instalment of the article, Part I of which appeared in the January-February issue.*

II. Intermediate Range—(1200° - 1800°F.)

B. Salt Bath Furnaces:

THE TYPE of furnaces to operate within this range are similar, with some modifications and exceptions, to those for the low temperature range. In the gas-fired furnaces, a blower is used to provide the necessary BTU for the high temperatures. The size of the blower will depend upon the size of the pot to be heated. A pot, say 12" diameter x 18" deep will require 1 HP blower to deliver 3000 cu. ft. per hour of air at 16 ounce pressure. Another pot, 16" diameter x 24" deep will need a blower 1½ HP to deliver 6000 cu. ft. per hour at 16 ounce pressure. Likewise, a pot 24" diameter x 30" deep will need a 2 HP blower to provide 9000 cu. ft. With gas-fired furnaces, especially at high temperatures, the question of pot life is a serious problem.

The pressed steel pots are reasonably satisfactory at the temperatures 1250-1550°F.; but at higher temperatures, 1750-1850°F., as may be required for stainless or air hardening steels, their life expectancy is very short and unsatisfactory. By calorizing, a process of coating and alloying the outside of a pressed steel pot with aluminum, the pot life is increased very appreciably. Some users report as much as 300% increase in pot life at 1550°F. For temperatures 1450-1550°F., a calorized pot more than pays for the additional cost. The most commonly used pots, however, for this range are cast alloy of three main analyses: one with 28-30% cr. balance iron; one with 35% nickel—15 chrome, balance iron; and one with 65% nickel—18 chrome, balance iron. Of these, the second type is used more often.

The producers of such castings have improved their foundry technique and the methods of inspection during the past years. The user seldom gets a pot with a definite casting defect such as blow holes, shrinkage cavities or insipient cracks. Yet, in spite of the overall improvement in the finished product, the life of a cast alloy pot is not altogether satisfactory, particularly with a neutral salt bath. There is an element of uncertainty or indefiniteness with an alloy pot using a neutral salt bath. Operating in the same furnace, with the same salt bath, apparently under identical conditions, one pot may last six months, and another one not even six weeks. On the other hand, alloy pots with the same analysis and from the same foundry will have consistently more uniform and longer life with carburizing bath. Precisely what the mechanism of failure of an alloy pot with a neutral bath is remains to be discovered. To avoid premature failure, a few suggestions may be made:

(1) Avoid direct flame impingement on the pot.
(2) Avoid localized overheating which not only scales the pot but also may introduce severe stresses, resulting sometimes in cracks.
(3) Desludge the pot regularly becauses ludge in the bottom prevents free circulation of the bath and causes overheating of the bottom.
(4) Turn the pot about 90° once a week.

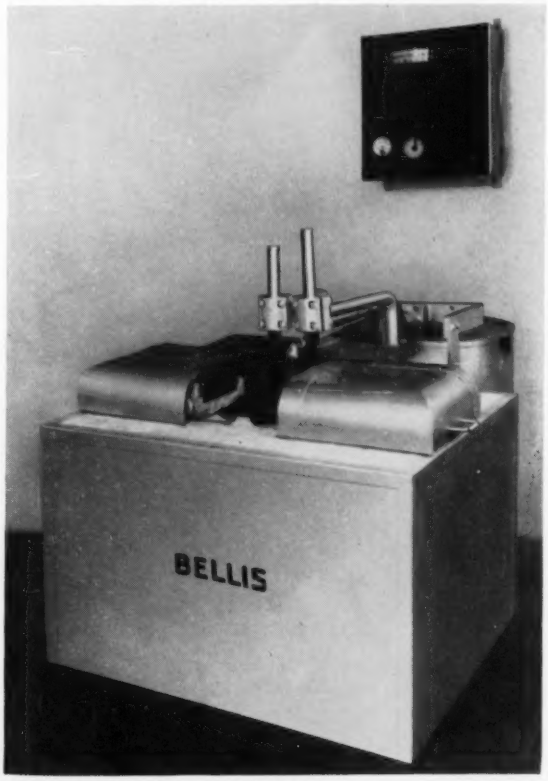


Fig. 1—An electrode-type salt bath furnace, using a ceramic pot, and operating at temperatures up to 1850°F.

(5) Seal the flange of the pot to the furnace top so that no salt spills and runs into the combustion chamber. Seepage of salt into combustion chamber causes premature pot failure.

(6) Have the flame slightly on the gas-rich or reducing side so that the flame will be longer diffused and the heat not so concentrated.

In addition, for satisfactory operation a modern gas-fired furnace should be provided whenever possible with pilots, either manual or electric spark plugs, and also should have flame failure protection. Now we may consider the furnaces to be heated by electricity within this range.

Electric-fired Furnaces

Since the calrod-type immersion element furnaces are limited to 1150°F., we will confine our discussion to the resistance-element and the electrode-type furnaces. In the resistance-element salt bath furnaces, the wall of the heating chamber is lined through suitable insulators with high resistance wire or ribbons. Passage of electric current heats the ribbon which heats the chamber and through the chamber the pot containing the salt bath. By the nature of its design, the temperature of the chamber is usually 150°-200°F. higher than that of the pot. For this reason such a furnace may safely operate at 1450°-1550°F., but it would not be advisable to operate it at the higher range because at the higher temperature the pot, commonly cast alloy, would scale heavily and fail prematurely. Since the heat has to be forced through the pot, scaling reduces the heat conductivity of the pot. This calls for additional heat, additional heat causes further scaling, and thus the vicious cycle continues until the pot fails. This condition can be remedied to some extent by removing the pot periodically, and knocking off the scale. Sometimes it is sand blasted, which helps to increase the pot life; and sometimes an auxiliary temperature control for the heating chamber is provided. This would prevent excessive temperature rise in the chamber.

Among the furnaces utilizing electric heat, the electrode type is more flexible as to size or temperature and is used more commonly for the temperature range of 1250°-1850°F. Such a furnace is shown in Fig. 1. Here the current is allowed to pass from one electrode to the other, immersed in the molten salt bath, and the resistance of the bath to the passage of current generates the heat. In this arrangement heating efficiency is very high, over 90%. The heat generated can be expressed with the equation $H = I^2R$, where H is heat in calories, I is current in amperes, and R resistance in ohms. In order to make use of this equation and generate the necessary heat, the line voltage, either 220 volt or 440 volt, is reduced by a transformer to secondary voltage of 10-20 volts, and the current increased from 100-400 ampere to 3000-4000 amperes. The secondary low voltages across the electrodes reduce the hazard of shock if touched by the

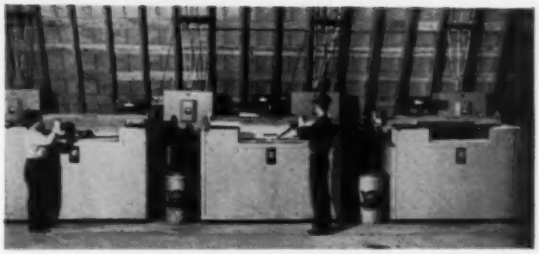


Fig. 2—A set-up of 3 electrode-type furnaces for the hardening of high-speed steels; a pre-heat, a high heat, and a quench.

operator. Such furnaces can be built to practically any size, ranging from 10" x 10" x 18" to 5' x 20' x 5' or larger.

The container or the pot in these electrode furnaces can be either fabricated metal, cast alloy or ceramic. To operate with a liquid carburizing bath, a fabricated metal pot is recommended. Cast alloy pots are costly and have limitations in size, but fabricated pots can be built to any size industrially required for heat treating.

To operate with a neutral salt, a ceramic pot is recommended. The ceramic bricks used for this purpose consist of a mixture of high grade alumina and silica. Such a suitable combination is sometimes found in nature with the proper percentage of each as in mullite or sillimanite. Often such combinations are made synthetically. Such a mixture, after proper sizing, is bonded and compressed to a porosity of less 10%, and fired at 3000°F. or higher.

A metal pot introduces metallic oxides into a molten bath, especially if operating at higher temperatures. These metallic oxides if sufficiently high in the bath may cause pitting and decarburization on tools. The ceramic pot eliminates this danger. Of course, a small amount of metallic oxides are introduced from the electrodes, fixtures or baskets holding the parts to be processed; but the amount is negligible. Normally these oxides mix with other sludge-forming materials and settle to the bottom of the pot. They may be removed periodically with a desludging ladle.

We should mention here a method used to remove metallic oxides from a neutral bath. This consists in introducing a carbon rod, about 2" in diameter into the bath, holding for 15-30 seconds and withdrawing. Some of the metallic oxides seem to be attracted and adhere to the carbon rod. After the carbon rod is removed from the bath, the adhering oxides are scraped off while still hot and soft. Such a carbon rod can be used over and over again, especially in a high temperature bath.

In a ceramic pot, although the trouble from the oxides is minimized, one has to contend with the problem of the breakdown of the salt bath itself. These baths are neutral to start with; that is, they neither carburize nor decarburize. But in the high operating temperatures, they undergo a slow decomposition; they break down and gradually oxidize to carbonates which

(*Continued on page* 38)

HYDROGEN EMBRITTLEMENT PUT ON THE SPOT

By **A. R. BOOKER,** Executive Vice President
EverLube Corporation
North Hollywood, California

Hydrogen embrittlement, that invisible hazard that plagues each engineer and production manager, has been at last put on the spot by a new time and temperature indicating paint, known as Tempa-Dot.

This new material is time and temperature sensitive formulated to change color at 375°F. The material in its original form is a bright red in color. With the aid of a handy applicator tube in which the Tempa-Dot is packaged, a small spot of bright red is put on the part which is to be hydrogen embrittlement relieved. After the part has been baked one hour the Tempa-Dot changes to a dull red; after three hours' baking, to a light golden brown; and after twenty-three hours, a dark brown to black.

In industry today, with the necessary pickling and plating required upon steel, hydrogen embrittlement becomes a very important hazard to cope with. For example, heat treated steels including the case hardened steels, are susceptible to embrittlement by hydrogen formed during pickling, cathodic cleaning or cathodic pickling, electro plating and phosphate treating. The higher the heat treat level, the greater is the possibility of part failure because of hydrogen embrittlement. Should the part be worked by bending, grinding or machining after heat treating, a stress will be exerted upon the surface of that part, therefore accelerating the effect of hydrogen. It is a common practice to minimize hydrogen embrittlement by heating the part to dry absorbed hydrogen from the metal.

Those parts or metals subjected to embrittlement can be a constant worry in any plant. The author does not pretend to be a metallurgist nor be an authority on which parts should be hydrogen relieved and which should not. In looking for an authority I believe that North American has set up a specification covering the hydrogen embrittlement problem which can be a rule for industries who wish to play ultra-safe. The following data, therefore, is a creation of North American Aviation and all credit should be given to the engineer who spent many hours in studying and writing this policy covering hydrogen embrittlement. The specifications follow this general trend. (See Table I on the following page.)

This chart not only is an excellent rule to follow

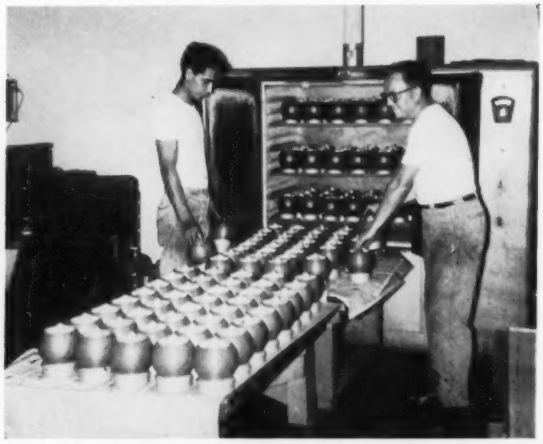


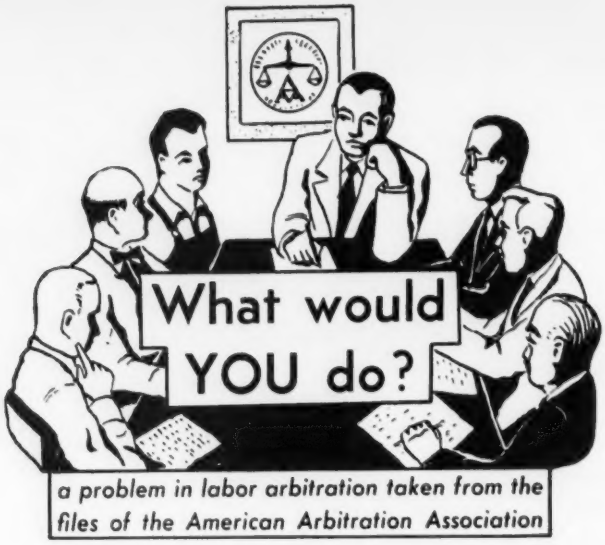
Fig. 1—Placing into a baking oven parts that have been painted with a time and temperature indicating paint.

but it also points up the great concern of the aircraft industry today in solving the hydrogen embrittlement problem. With the increasing stresses to which metals are being subjected, each potential hazard of part failure is viewed with utmost concern. The problem that has faced such industry in the past is one of human error, i.e., that parts pickled or cadmium plated could be certified as having been hydrogen relieved, but through an error this baking procedure could have possibly been overlooked. With the blanket certification no production manager could be assured that the individual part he was assembling had been actually baked to relieve hydrogen embrittlement. Since the Tempa-Dot is applied to the individual part as a small individual dot, this dot is retained on that individual part up to assembly and becomes a visual indicator that the part has been baked. That tell-tale color of the tiny dot not only indicates the baking temperature but also the baking time. Should the part have slipped through without baking to relieve hydrogen embrittlement, that individual dot becomes a tiny stop light flashing brilliantly red to warn the production manager of the hazard of hydrogen embrittlement contained therein.

The new Tempa-Dot material is packaged in a ball applicator tube which is easily applied by the unskilled worker. • • •

Table-1 Embrittlement Relief Procedures

SCHEDULE	STRENGTH RANGE	TYPE OF STEEL REQUIRING RELIEF TREATMENT	OPERATION NECESSITATING RELIEF HEATING	PLACE TO CALL FOR RELIEF HEATING	LENGTH OF HEATING	TEMP. OF HEATING (F)
A	140,000 to 160,000 psi (Rockwell C-32 to C-36)	Carbon and alloy steels	Cold forming	After final pickle, or plating	3 hr.	375 ± 25
B	160,000 to 180,000 psi (Rockwell C-36 to C-40)	Carbon and alloy steels	Soak pickle	After pickle	3 hr.	375 ± 25
			Plating	After plating	3 hr.	375 ± 25
C	180,000 to 220,000 psi (Rockwell C-40 to C-46) and parts having other heat treat ranges	Carbon and non-stainless alloy steels	Grinding on unplated parts	After grinding prior to pickle or plating	2 hr.	675 ± 25
			Grinding on unplated areas of plated parts	After grinding prior to pickle or plating	3 hr.	375 ± 25
			Soak pickle	After pickle	3 hr.	375 ± 25
			Plating or phosphate treatment	After any plating operation other than final plating. After phosphate treatment	3 hr.	375 ± 25
				After final plating or after final plating and phosphate treatment operation	23 hr.	375 ± 25
			Cold straightening	After straightening, prior to pickle or plating	2 hr.	675 ± 25
D	220,000 to 240,000 psi (Rockwell C-46 to C-49)	Carbon and non-stainless alloy steels	Grinding on unplated parts or on unplated areas of plated parts	After grinding prior to pickle or plating	3 hr.	375 ± 25
			Soak pickle	After pickle	3 hr.	375 ± 25
			Plating or phosphate treatment	After any plating operation other than final plating. After phosphate treatment	3 hr.	375 ± 25
				After final plating or after final plating and phosphate treatment operation	23 hr.	375 ± 25
E	180,000 psi and above (Rockwell C-40 and above)	Music wire, Nitrided Steels, AISI 400 series stainless steels	Grinding	After grinding prior to pickle or plating	3 hr.	375 ± 25
			Soak pickle	After pickle	3 hr.	375 ± 25
			Plating and/or phosphate treatment	After plating and/or phosphate treatment	3 hr.	375 ± 25
			Cold straightening except music wire	After straightening, prior to pickle or plating	3 hr.	375 ± 25
F	Rockwell C-48	Case carburized steel, induction hardened steel, 52100 steel, drill rod	Grinding	After grinding prior to pickle or plating	3 hr.	325 ± 25
			Soak pickle	After pickle	3 hr.	325 ± 25
			Plating or plating and phosphate treatment	After plating or after plating and phosphate treatment	23 hr.	325 ± 25



The Case of the Missing Tools

When a contract was negotiated in a machine shop, the parties agreed upon a clause which said that "the employer will supply tools for the employees to use free of cost." Over a period of time, however, the company noticed that some tools were disappearing and others were damaged through negligence. To correct the situation, the tool room attendant was instructed to fill requisitions for tools only to employees who signed a statement saying: "On the receipt of these tools I agree to authorize the company to deduct from my wages the reasonable value of any tool I fail to return or damage through negligence."

The union immediately filed a grievance, claiming that this was a violation of the contractual provision governing free supply of tools. Management disagreed. "We're supplying tools free of charge as we agreed to do," the foreman said. "All we want to do is to stop pilfering and carelessness."

Eventually, the case went to arbitration.

What Would YOU Do?

THE AWARD: The arbitrator said the union was right. For use of the tools to be "free," he said, they must be made available without restrictions or obligations. The contract clearly made the tools a cost to the company, not to the employees. He acknowledged that the company had the right to keep those costs down and to prevent abuse, but the method used would have to be one which did not violate the agreement. The arbitrator added that it was not within his authority to suggest a method that would be proper, but he hinted that there was nothing to stop management from requiring replacement of a tool lost or negligently damaged by the employee to whom it was issued.

The Case of the Re-assigned Cabinet Maker

When an order for television cabinets was cancelled suddenly, management of a furniture manufacturing company assigned three men from the cabinet line to other work in the same department. There was no change in job classification or rate of pay. One of these men, asserting his top seniority, objected.

"There's still some TV cabinet work to be done," he said, "and I've got the right to do it under the contract." The clause he cited read: "In the event of decrease of force within a department, seniority shall govern."

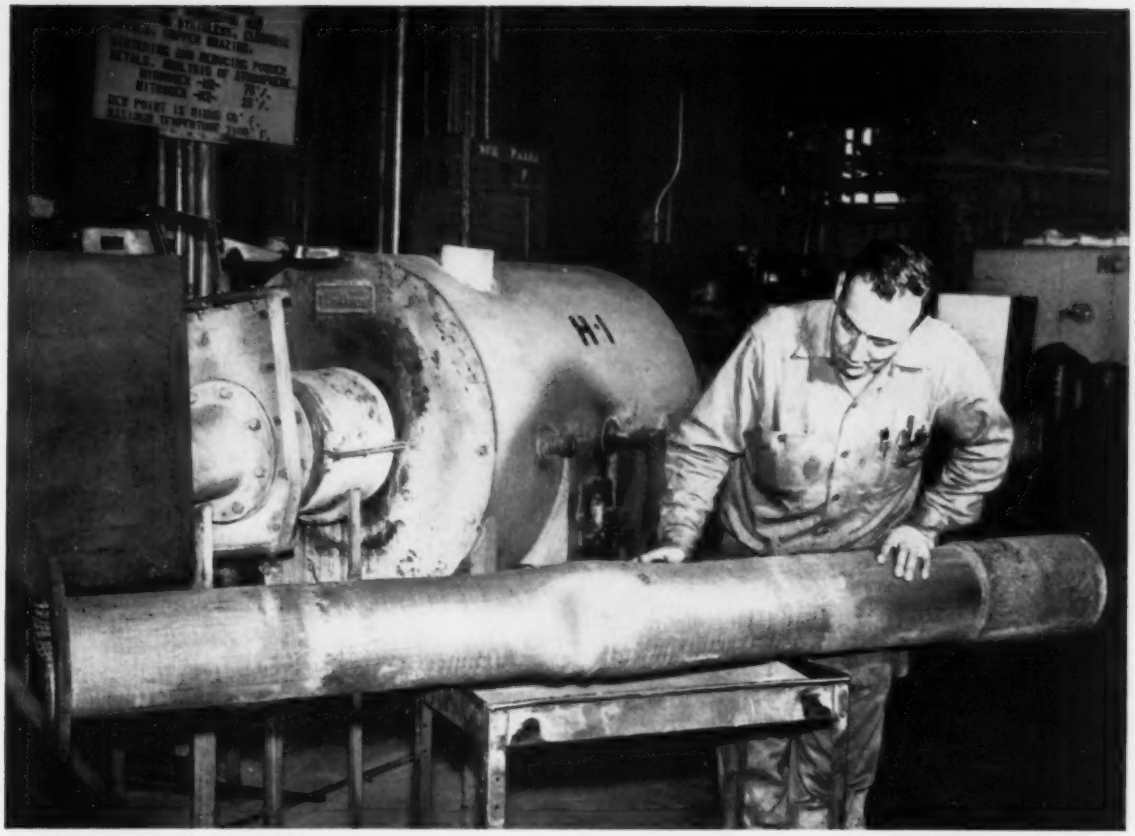
"That clause doesn't apply here," answered the foreman. "There's no layoff involved, only a new assignment within the department without any change in pay or level of skill. All we're doing is exercising the usual right to 'direct the work forces'."

Eventually, the case went to arbitration.

What Would YOU Do?

THE AWARD: The arbitrator said the contract would have to be interpreted in such a way as to give meaning to *every* clause. To uphold the union's position would be to deny meaning to the management prerogative section. He concluded: "The most reasonable interpretation of the Agreement as a whole is that simple transfers among equal paying jobs within a department not connected with a reduction in the total number of employees in the department are not governed by seniority provisions."

CAUTION: The awards in these cases are not an indication of how other arbitrators might rule in other apparently similar cases. Arbitrators do not follow precedents. Each case is decided on the basis of the particular history, contract, testimony and other facts involved.



No failure of muffle, burner, nor refractory has occurred in the six years since Lindberg Steel Treating Co. of California installed the Hydrogen annealing furnace shown in the background of this picture. Muffle is Inconel alloy. Furnace was made by Lindberg Engineering Co., Chicago.

See how Inconel alloy stands up in bright annealing service!

After six years...half the time above 2050°F ...muffle is still strong, still gas tight

The Inconel* nickel-chromium muffle shown above has just been removed from the Lindberg, gas-fired, hydrogen-atmosphere furnace immediately behind it.

After six years of bright annealing stainless steel, bright hardening, copper brazing and powdered metal sintering . . . after six years at temperatures of 1300° to 2100°F. . . . after six years of dissociated ammonia atmospheres inside the tube and combustion gases outside . . . the muffle is being retired.

Not because of weakness! Not because of gas leaks! Not because of frequent repair! You can see none of these possibilities hold.

There *is* some distortion midway along the tube. And just as you might do, the operators are taking the prudent step of replacing in advance of actual need. With this evidence before you, you can anticipate what alloy they will use.

Because it's Inconel alloy, production of the replacement will be simple and fast. Inconel alloy is outstanding for production versatility. Easy to form. Easy to weld. This is borne out by the tremendous variety of equipment now being made of this useful high temperature material.

Would you like pictures, descriptions, and service records of some of these items of equipment? Send for the Inco booklet, "Keeping Operating Costs Down as Temperatures Go Up".

*Registered trademark

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INCO TRADE MARK

INCO NICKEL ALLOYS

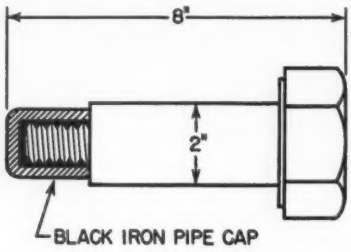
HEAT TREATING HINTS

Bolts That Failed

By DAVID R. EDGERTON

Lindberg Enginering Company, Chicago, Illinois

Peter Paulson, Vice President in charge of sales for the Paulson Tool Company, was worried. One of his nice, steady, "Bread and Butter" jobs had gone sour. Three years before, Pete had sold the Railway Products Company on changing over from their original source on their line of Shoulder Bolts. For fifty years they had been specifying a 1010 Forged Bolt, carburized and water quenched to 61-62 Rockwell "C."



Since the bolts were in shear and under considerable pressure, failures occurred due to spalling and cracking. Pete properly diagnosed the failure as due to the soft core sinking and recommended the use of of C1137 steel with a thinner carburized case. The savings in machining time, straightening and scrap loss more than made up for the added expense of gas carburizing. The new specifications read:—"stack vertically on fixtures, gas carburize 1550°F. for .020-.030" case depth, oil flush quench and draw 350°F. to 60-62 Rockwell 'C'." For the past 3 years the bolts had been perfectly satisfactory. No cases of failure in the field had been reported; but here was a letter and a very "hot" letter stating that "several shoulder bolts had twisted off at the thread in assembly and that they were returning the last shipment for credit." The letter further stated that their specification for the old bolts had called for "soft threads" and that these were "file hard" on the thread.

Pete had argued vainly that he had been furnishing the bolts exactly the same way for 3 years. Railway Products Engineers insisted that they wanted soft threads. Actually, a little research had developed the fact that some of the boys had added a 3 ft. length of pipe to the standard 2 ft. long wrench, until the foreman caught them and stopped the practice. Pete hesitated to upset his friendship at the foreman level by spilling the beans!

Finally he called in "old Mac." "Mac,—how can I give Railway Equipment Co. soft threads on their shoulder bolts? Painting the threads or plating them would cost too much; we can't turn off the end after carburizing and then thread—that would cost even more. Induction Salt or Lead Pot annealing is handwork and would again cut into our profit."

As usual, Mac came up with the answer. A standard black iron pipe cap was rethreaded to fit the bolt. The cap was spun onto the thread by the threading machine operator as the final operation of thread milling was completed. Caps were dipped in white lead to prevent freezing, and bolts were treated as before. The threads picked up a little toughness from the quench but were soft enough to meet the specifications. The caps could be used for 50 or more heats and their cost was negligible. An added dividend was a reduction of spoiled threads—the threads were protected in handling.

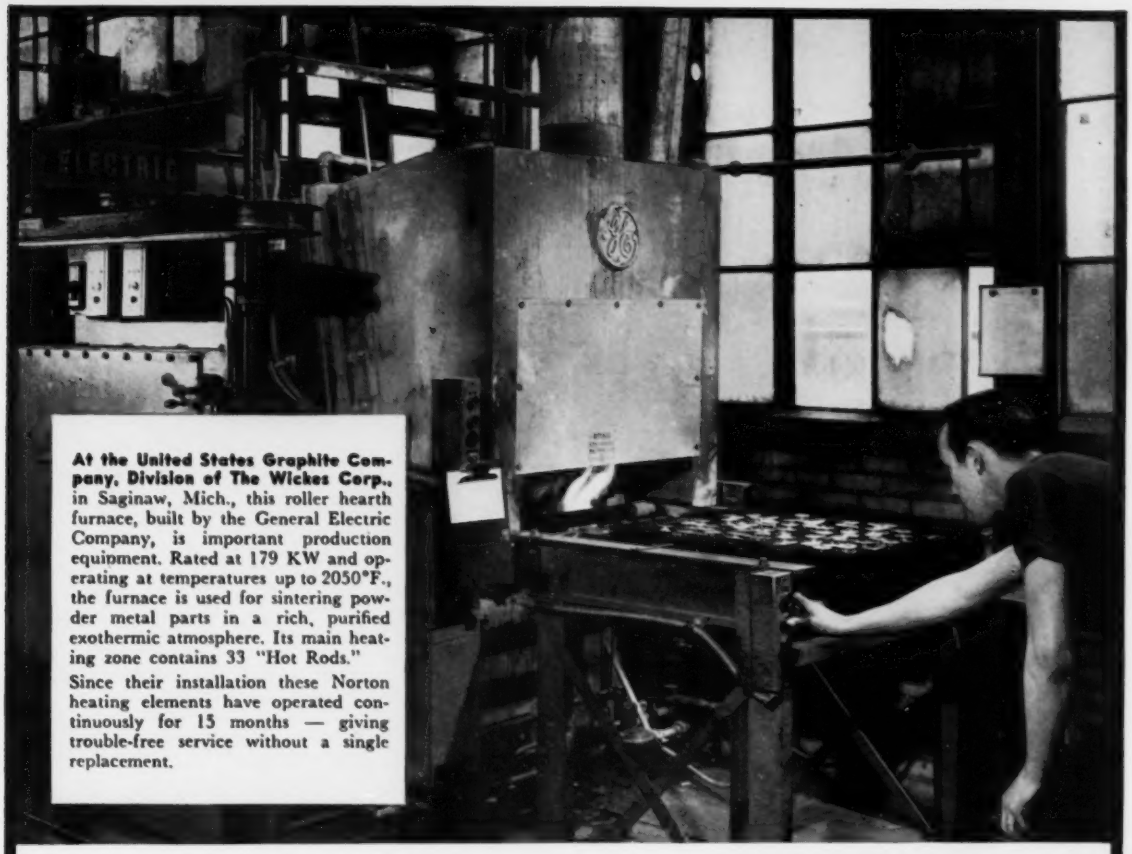
Ratchets That Failed

Bill Grimm, Sales Manager of the Quality Tool Works, was also worried. He had planned to send out 10,000 special wrenches of a new design to his jobbers after first trying out 1,000 samples in his own shop and with the suppliers. The samples worked beautifully, but the first production lot had failed miserably due to chipping and spalling of the ratchet teeth, the heart of the wrench.

Production had been stopped, and Bill had called a meeting of the management in Production along with the purchasing agent and heat treater.

The ratchets had been originally made of 4615 steel — carbonitrided .010"-.020" at 1650°F. — oil quenched and drawn 450°F. to a hardness of 57-59 Rockwell "C" by 15 N. conversion. Old John, the heat treater, produced his records showing that the treatment had been followed to the letter. The inspection

(*Continued on page* 31)



At the United States Graphite Company, Division of The Wickes Corp., in Saginaw, Mich., this roller hearth furnace, built by the General Electric Company, is important production equipment. Rated at 179 KW and operating at temperatures up to 2050°F., the furnace is used for sintering powder metal parts in a rich, purified exothermic atmosphere. Its main heating zone contains 33 "Hot Rods."

Since their installation these Norton heating elements have operated continuously for 15 months — giving trouble-free service without a single replacement.

At The United States Graphite Company...

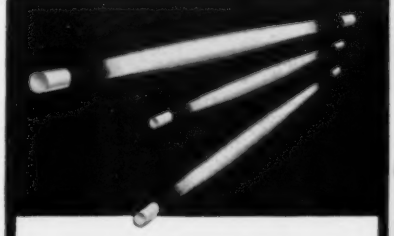
"HOT RODS" give long lasting service life

Norton CRYSTOLON heating elements are excellent performers in an Electric Sintering Furnace*

Norton "Hot Rods" are outlasting other non-metallic heating elements *up to 3 to 1!* Such reports from many plants mean that you too can save with these heating elements, because they need less replacing than other elements. Also, you get reduced maintenance, due to less changing of elements or voltage taps. And "Hot Rods" help protect product quality, because their slow, evenly matched rate of resistance provides more uniform heating.

For further facts on how "Hot Rods" can help improve your furnace operations and cut costs, send for booklet, *Norton Heating Elements.* NORTON COMPANY, Refractories Div., 622 New Bond St., Worcester 6, Mass.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries



Norton CRYSTOLON Heating Elements, or "Hot Rods," are a typical Norton Rx — an expertly engineered refractory prescription for greater efficiency and economy in electric kiln and furnace operations. Made of self-bonded silicon carbide, each rod has a central hot zone and cold ends. Aluminum-sprayed tips and metal-impregnated ends minimize resistance and power loss. Available in standard sizes.

NORTON

REFRACTORIES

Engineered... Rx ...Prescribed

Making better products... to make your products better

NORTON PRODUCTS
Abrasives • Grinding Wheels
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BEHR-MANNING DIVISION:
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Behr-cat Tapes

ABSTRACTS

INDUCTION HARDEN SMALL LOTS FOR EXTRA BENEFITS

by
R. T. Hook, Chief Metallurgist
The Warner & Swasey Co., Cleveland

Induction hardening is often considered as a specialized method of heat treating that applies only to fancy designs or mass production items. Where this view is held, engineers often design away from the use of localized hardening by going to more expensive methods or materials.

Techniques used at The Warner & Swasey Co. have proved that this viewpoint is not always valid. In 1948, the firm bought a 450 kc, 50 kw induction hardening unit to harden the bed ways of ram-type, turret lathes. The equipment also had a work table for hardening small parts.

A growing volume of small-part hardening soon taxed equipment capacity to the point where a separate power source was bought for the bed-hardening unit.

In 1952 the firm expanded, setting up a plant at New Philadelphia, Ohio, which could use the high frequency machine and its work table to good advantage. This left the question of what type of replacement equipment should be bought for the Cleveland operation.

A motor generator-powered unit was proposed, and a study of eight parts which could be handled on such equipment was made to see if the expense was justifiable.

When an estimated annual saving of $7,156 was indicated for these eight items, it was decided to buy a motor-generator set and ship the old 50 kw unit to the new plant.

Having outlined the parts to be treated, a special unit was designed by the motor-generator manufacturer to accommodate them. The traveling length was 65 in. for long, slender parts with an outside diameter of 27 in. for gears.

The final unit decided upon consisted of a 100-kw, 10,000 cycle motor-generator set, a field station, a small hardening unit which traverses a 30-in. length and about a 9-in. OD. There was a large fixture which can handle a 65-in. length and 27-in. OD, quenching parts in oil or water.

Where it was normal practice to use AISI A-4150 steel for gears in furnace quenching, AISI A-4145 proved better for reducing cracking at the root of the teeth on induction hardening.

In cases where C-1045 materials had been used on large parts, the material was changed to C-1050 for parts over 3 in. diameter to obtain proper hardness.

In all cases, however, temperature of the quench emulsion must be kept under 90°F. for carbon steels and 130°F. for alloy grades to get uniform hardening.

A good example of distortion control by the use of induction hardening is the case of a sleeve gear of 6½-in. diameter. One lot of 125 pieces, normalized and annealed by an outside source, was quenched in a normal atmosphere furnace. Of this lot 90 pieces were more than 0.005 in. out of round after quenching and tempering.

A second lot of this same part was then normalized and annealed in the company's own plant and run through the same furnace procedure. In this case 20 pieces of the 125 exceeded the 0.005 in. limit.

A third lot of 125 pieces, selected, normalized and annealed in the company's plant, was martempered in order to reduce distortion. Only six pieces of the 125 exceeded tolerance limits.

The fourth lot was treated with the induction method. The teeth only were hardened and then quenched in the emulsion. Inspection showed that not one piece was out of round.

These successful results on gears are obtained by hardening ⅛ in. below the root of the tooth and quenching in the emulsion, following with a tempering operation at 450°F. Hardness is maintained at 50-55 RC. Timers on the induction unit are checked regularly to see that hardening cycles produce consistent results.

To reduce handling time, the tempering furnace for all induction hardened work is adjacent to the induction unit.

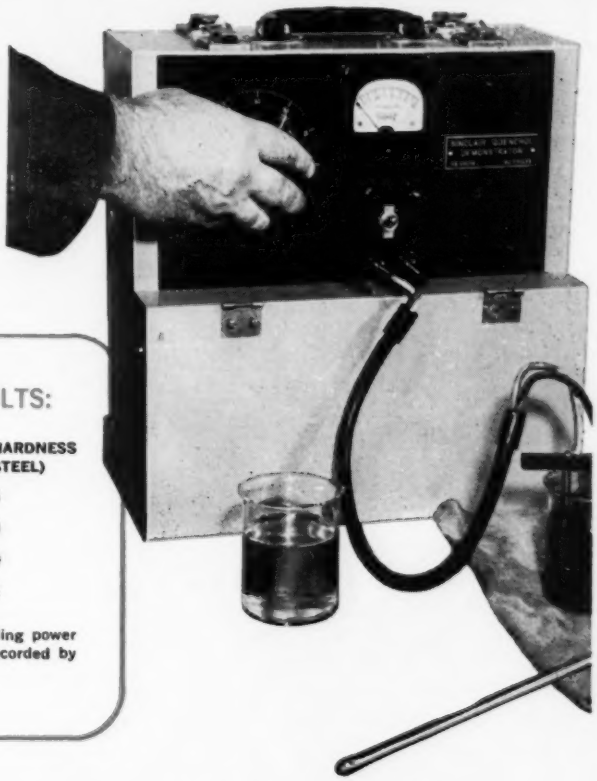
Because the plant does not work a third shift, some means had to be devised for using the induction unit on the entire second shift. The solution was to put timers on the tempering furnace which allow parts to remain therein over night. Setting a timer shuts the heat off at any specified time. Thus, work is cooled by morning and ready for unloading.

Source—The Iron Age, Sept. 1957

TEST PROVES QUENCHOL'S HIGHER COOLING POWER!

10-MINUTE DEMONSTRATION

Compare any oil you now use with Sinclair QUENCHOL 521 in just 10 minutes! Right in your office or plant, Sinclair's new Quenchol Demonstrator will give you an accurate comparison of relative cooling power . . . show you how QUENCHOL can save money in your quenching operations!



A TYPICAL TEST SHOWS THESE RESULTS:

OILS COMPARED	COOLING POWER*	ROCKWELL C HARDNESS (SAE 1045 STEEL)
Competitive Oil A	576	23.5
Competitive Oil B	729	39.0
Competitive Oil C	1024	41.0
QUENCHOL 521	1369	54.5

*Based on a recognized formula for determining relative cooling power value. Measured as the square of the current (I^2max.) as recorded by Quenchol Demonstrator.

ACTUAL PRODUCTION TOO...PROVES QUENCHOL SUPERIORITY!

In numerous production tests, QUENCHOL 521 has demonstrated its far superior quenching ability. All users report better results in the degree, depth, and uniformity of hardnesses obtained. Steels have included SAE 1035, 1040, 4140, etc. In many cases the superior results have been obtained while increasing working loads! Moreover, QUENCHOL's high sludge resistance, low acid formation characteristics and *high quenching reserve* keep it from deteriorating . . . extend QUENCHOL's amazing cooling power with longer service life!

For your own demonstration of QUENCHOL efficiency, and for more technical information on its properties, call your local Sinclair Representative . . . or write to Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. *There's no obligation.*

SINCLAIR METAL WORKING OILS

THE APPRENTICE CORNER

HEAT TREATMENT DATES BACK TO ANCIENT TIMES

Many centuries ago the blacksmith learned how to use heat treatment as a means of hardening wrought iron. In forging iron on his anvil, he repeatedly heated it in a charcoal fire between hammerings. When the forging was completed and he thought its temperature was high enough, he plunged it into water, oil or other liquid. When the forging was removed from the quench, it was very hard.

According to the ancient Roman writer Pliny, the hardening was due to the hammering and the heat. But most of the old-time smiths attributed it to the quench. Some of them thought that successful hardening depended on the quality of the water or the kind of oil used in quenching. Others prepared special quenching solutions containing such odd additions as the juice of radishes mixed with the juice of earthworms. Not a few imaginative smiths concocted supposedly magical quenches, whose mysterious contents were closely guarded secrets.

The early smiths were, of course, right in attaching so much importance to quenching, since it was the sudden cooling which hardened their metal. However, there were probably not too many of them who knew that no quenching liquid would harden their forgings unless the iron contained carbon absorbed from the forge fire.

The absorbed carbon was the key to hardening. It transformed the smith's forged iron into steel, a hardenable metal. And it did not take much carbon to bring this about, since it requires less than 1.8 per cent of contained carbon to change wrought iron into steel.

Carbon is the principal source of the hardness and strength of steels. Grades of steel in which carbon is the main element used to control their characteristics are called "carbon steels." Steels which, in addition to carbon, contain other elements in sufficient amounts to modify their properties are called "alloy steels."

Carbon is able to harden and strengthen steel because the iron in which the carbon is contained consists of crystals, or "grains," which can exist in different forms.

When the metal is heated to a high enough temperature, the grains are made up of one type of cubic crystal cells. When the metal is cooled below its "transformation temperature," these cells are replaced by cubic cells of another type. Above the transformation point the carbon is entirely dissolved in the iron crystals, even though the metal remains solid. Below the transformation temperature the carbon either sets up stresses in the newly formed cells or it combines with the iron to form iron carbide.

The appearance of the new crystal cells is accompanied by the formation of new grains, which are of various types, depending on the amount of carbon contained in the metal and the rate at which the metal is cooled.

It is this variation in the kind, quantity and size of grains that determines the properties of steels. The arrangement of the grains in a given steel is visible only under a microscope and is therefore called its "microstructure."

What the old-time blacksmith unwittingly did was to heat his carburized forging above the metal's transformation temperature. When he then quenched the forging, the sudden cooling caused the formation of a very hard microstructure, which has been given the name "martensite." Since the hardened forging was too brittle, the smith reheated it to a somewhat lower temperature, which he judged by the color of the heated metal, and again quenched it. This operation, called "tempering," removed enough hardness and introduced enough plasticity to make the metal tough rather than brittle.

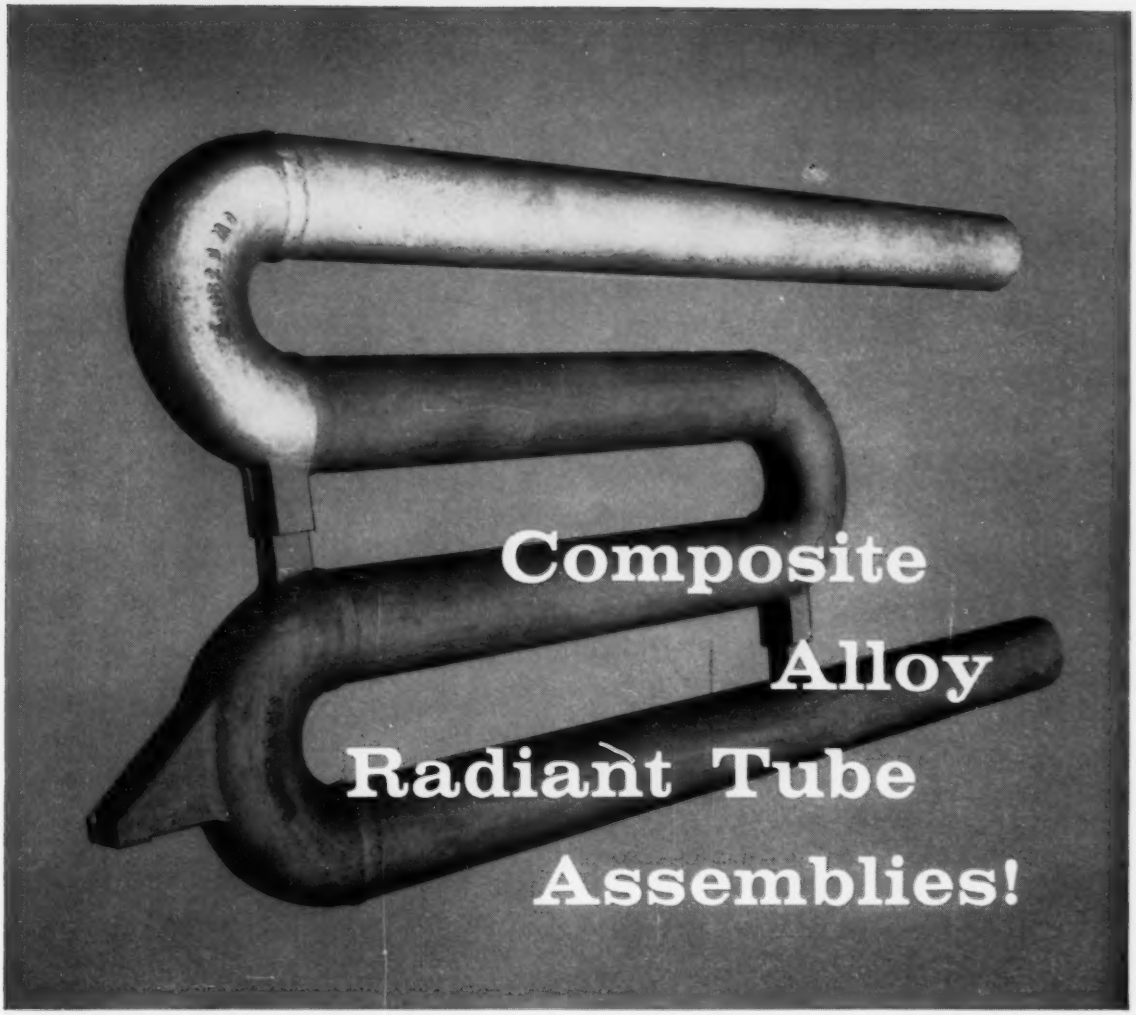
Hardening, followed by tempering, is one of the most familiar forms of heat treatment, but there are others, all of which are used to control the steel's microstructure.

"Annealing," for example, is used to relieve stresses set up in the metal by rolling, drawing, or forging, and to soften the steel so that it can be more easily machined and formed. "Normalizing" is used to replace coarse grains in a steel with a uniform, fine-grained microstructure.

The blacksmith of olden times judged temperatures by the color of the heated bar he was forging, and he had no precise knowledge of the quality of the metal in the bar or any comprehension of its chemical composition.

Today heat treatment is a science. The steels that are heat-treated, as distinguished from the iron forged by the ancient smith, already contain carbon. The percentages of carbon and other elements present in a given steel are known, and heat treating equipment is available that will give the steel the precise microstructure desired.

Source—U. S. STEEL NEWS



Critical section of the radiant tube assembly is cast from 22H to provide greater heat resistance. The balance of the assembly is cast from an alloy of the proper grade for optimum service in individual furnace.

Provide greatly increased tube life

The new National Alloy radiant tube assembly is designed and built for maximum service under the punishing conditions found in all types of radiant tube furnaces. Its special construction puts alloys with greater heat resisting properties into critical sections of the assembly.

In pilot installations this added ruggedness has resulted in two to three times the tube life previously experienced. This fresh approach in meeting the strict requirements imposed by higher heat treating temperatures results from special know-how and infinite care in construction.

As the leading specialist in high temperature alloy castings for radiant tube furnaces, National Alloy has had unique experience in dealing with the problems brought about by elevated temperatures, and the men and machines to give you the practical answer. For the full story on how composite alloy radiant tubes may improve your heat treating operations, contact National Alloy today. No obligation of course.

BLAW-KNOX

BLAW-KNOX COMPANY

National Alloy Division
Pittsburgh 38, Pennsylvania

NA

M.T.I. *Activities*

1958 SPRING MEETING

Camelback Inn, Phoenix, Arizona, has been selected as the headquarters for this year's Spring Meeting of the Metal Treating Institute which will be held on April 21, 22, and 23.

The facilities of this famous resort for the technical and business sessions as well as for pleasure are excellent. A balanced technical program is being arranged for the morning sessions, and each afternoon and evening will be devoted to the use of the outstanding recreational facilities.

The excellent Paradise Valley Country Club borders the Inn with an 18-hole, all-grass, all-green, par-72 golf course available. In addition, guests may make use of the glass-enclosed swimming pool which is heated to 80 degrees, as well as the tennis courts and riding stables. Also available are bingo, canasta and bridge parties, and a complimentary "Hopalong College" supervises the activities of children from 4 to 12 years of age.

One of the special activities being planned for the MTI members is a special "steak fry" cooked out-of-doors at the foot of Mummy Mountain with "honest-to-goodness" real cowboys.

No member should miss this meeting; reservation blanks have been sent and should be returned directly to the Inn as soon as possible.

Lincoln Woodworth

It is with deep regret that we announce the sudden passing of member Lincoln Woodworth, President of Lincoln Heat Treat, Inc., Hazel Park, Michigan, on Tuesday, January 28th.

NEW MTI CHAPTER

The Board of Trustees of the MTI has approved the petition for a charter of a new regional chapter to be known as the Texas Chapter of Metal Treating Institute. The member companies of the chapter are:

Cook Heat Treating Co. of Texas
Dominy Heat Treating Co.
Houston Heat Treating Co.
Lone Star Heat Treating Co.
Superior Heat Treating Co.
United Heat Treating Co.

The chapter officers are Chairman, Mr. M. B. Dominy of Dominy Heat Treating Company, and Secreary-Treasurer, Clifford M. Cook of Cook Heat Treating Company of Texas.

BOARD OF DIRECTORS MEETING

A meeting of the Board of Directors of the MTI was held in Chicago at the Hotel Sheraton on February 25-26, 1958. The following attended:

K. U. Jenks, President; John P. Benedict; A. L. De Hart; M. B. Dominy; Clarence F. Graham; Norman R. Hodgson; John H. Ries; C. E. Herington, Executive Secretary; and T. C. DuMond, representing the American Society for Metals.

Mr. DuMond described a proposed change in the scheduling of the Annual Meeting of the MTI to combine it with the ASM technical sessions during the Metal Show Week in October of 1958. This matter was taken under advisement for voting by the members.

During the meeting many other activities and projects of the MTI were discussed and action taken. Discussion regarding the compilation and publication of a Heat Treating Handbook by the Institute ended with the decision that preparation of such a booklet should be pushed to its conclusion.

It was also decided that renewed efforts to increase membership will be part of the program for the balance of the year.

NEW MTI MEMBERS

The following five companies have been admitted to membership in the Metal Treating Institute with the necessary approval of the Board of Trustees:

Ipsenlab of Canada Limited
27 Bermondsey Road
Toronto 16, Ontario, Canada
Mr. Frank Hobbs
—General Manager

Owego Heat Treat, Inc.
Rural Route 1
Apalachin, New York
Mr. William E. Engelhard
—President

Allied Metal Treating Corp. of Illinois
333 North California Avenue
Chicago 12, Illinois
Mr. Victor Bozick
—Treasurer

General Heat Treating Corporation
206 Sand Street
Syracuse 3, New York
Mr. Sylvester E. Edwards
—Secretary

Houston Heat Treating Company, Inc.
2100 Quitman Street
Houston 26, Texas
Mr. LaMar J. Vieau, Jr.
—President

(Continued on page 40)

How to find a better heat-treating method

Here's a sound way to do it. Take your problems to the people who have consistently, over the years, provided the metal treating industry with new and better ideas, more efficient, more practical equipment. This will bring you to Lindberg, creators of the famous Cyclone type atmosphere furnaces, the long-life "dimple" vertical radiant tube, the revolutionary new CORRTHERM electric heating element and so many other innovations in better heat treating methods. Lindberg is synonymous with heat treating furnaces. We build them for carbonitriding, carburizing, hardening, tempering, normalizing, bright stainless annealing, brazing, carbon correction, nitriding, or any other metal treating requirement. Give your production processes the advantages of Lindberg's forward look in "heat for industry" techniques. Get in touch with your nearest Lindberg Field Representative (See classified phone book) or write Heat Treating Furnace Division, Lindberg Engineering Company, 2466 W. Hubbard St., Chicago 12, Illinois.

LINDBERG heat for industry

NEWS TO HEAT TREATERS...

TOOL SHOW EXHIBIT

Maximum tool hardness without scale or decarb will reduce tooling and production costs. These features are said to be easily obtainable in Sentry furnaces and will be demonstrated in Booth 436 at the A.S.T.E. Tool Show in Philadelphia, May 1-8.

A Sentry Model "Y" furnace as shown here will be in operation producing clean hardening on the easily decarburized M-10 high speed steels.

Visitors to the Show are invited to bring samples of their high carbon, high chrome, or high speed steel tools for demonstration hardening.

For further information circle No. 1

SURFACE PYROMETER

Pyrometer Service Co., Inc. has announced a new model surface pyrometer. By selecting the proper pick-up element, it measures temperature up to 1500°F. on flat or curved surfaces, platens, injection molding heads, plastic molding dies, revolving drums, or shafts, subsurface liquids or low melting soft metals and plastics.

New exclusive swivel head permits operator to measure temperature at any angle or deflection and still keep dial of instrument visible at all times. Without the use of tools, the instrument can easily be converted to the cable type by inserting a special cable between the instrument and the rigid pick-up arm.

For further information circle No. 2

NEW DIPPING PROCESS

The Upton Electric Furnace Company, Inc. has announced the development of a new process for coating steel with aluminum while both metals are heated to temperatures ranging from 1300° to 1650°F. By this method, steel can simply and economically be made to withstand many years of exposure to weather or coastal atmospheres without the need of periodic painting or any other protective coating.

This aluminum coating also protects steel from corrosion caused by heat—and at the present time is being considered for use on automotive mufflers. Tests have proven that mufflers fabricated with aluminized steel triple their life.

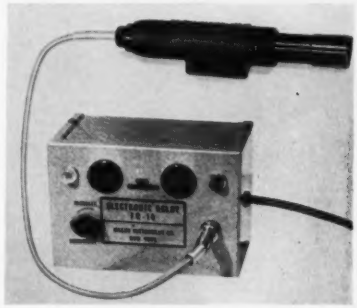
This new process is accomplished by use of the patented Upton electric salt bath furnace. Pure aluminum is melted and floated upon a barium chloride base in the bath or pot of the furnace, and a flux is floated on top of the aluminum. Steel to be aluminized is then dipped in and out of this bath and immediately transferred into another furnace (containing only molten salt) of the same temperature. Here, the steel is dipped in and out in the same manner for the purpose of smoothing out the aluminum and for the removal of the flux.

In addition to mufflers, the process is being considered for use on many other automotive items, as well as for military and structural purposes.

For further information circle No. 3

TEMPERATURE MONITOR

Originally developed to automate a production line using induction heating, the PYROTROL is proving its usefulness as a noncontacting temperature monitor and control. It performs equally well with induction heater, crucible, gas flame, torch, or furnace.



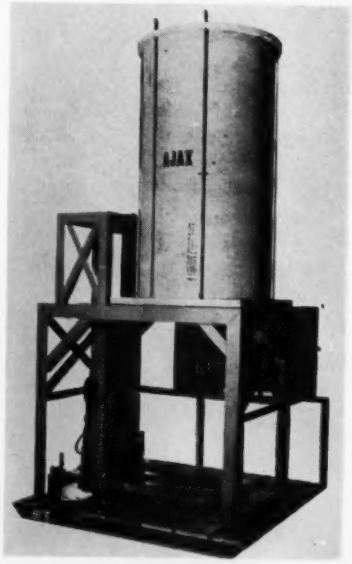
It operates at a distance from 6" up to many feet away without touching the work. It is not sensitive to flame and reacts only to the radiation emitted by the hot target.

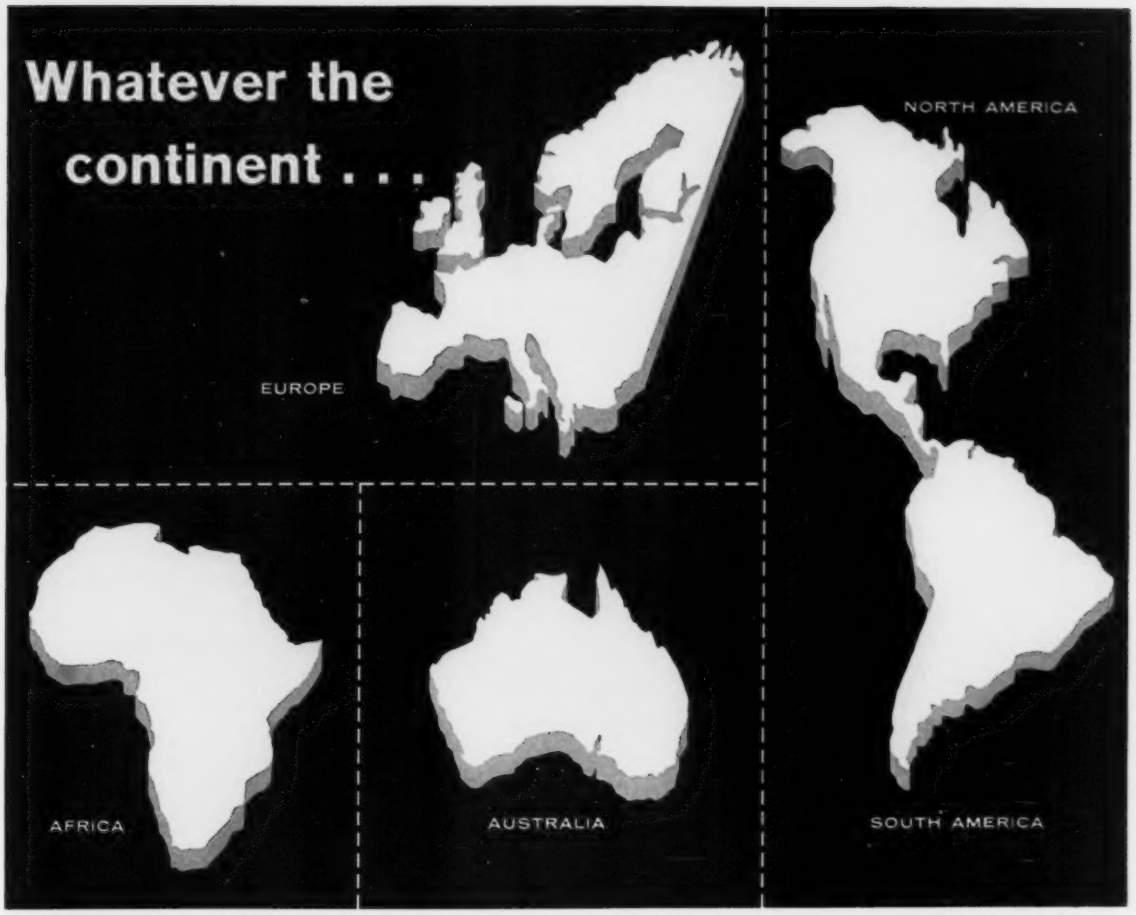
For further information circle No. 4

CARBIDE SINTERING FURNACE

Significant production savings are built into a new and unique carbide sintering furnace just introduced by Ajax Electrothermic Corp., Trenton 5, New Jersey.

Based on the proved high temperature advantages of high fre-





Its performance and name are the same around the world

Other Outstanding Shell Industrial Lubricants

Shell Tellus Oils—for closed hydraulic systems

Shell Alvania Grease—multi-purpose industrial grease

Shell Turbo Oils—for utility, industrial and marine turbines

Shell Rimula Oils—for heavy-duty diesel engines

Shell Talona R Oil 40—anti-wear crankcase oil for diesel locomotives

Shell Dromus Oils—soluble cutting oils for high-production metal working

Shell Macoma Oils—for extreme pressure industrial gear lubrication

Shell Voluta Oil is a stable high-speed quenching oil that proves ideal for use in both static and circulating quenching systems.

Voluta® Oil offers two unique characteristics: (1) It remains stable at temperatures up to 180°F. with no appreciable sludge formation. (2) It permits safe, rapid quenching of parts which ordinarily have a tendency to distort.

Voluta Oil is available on a world-wide basis, and you can be sure your customers *abroad* will get the same performance from your quenching equipment that your domestic customers rely upon. Write for complete information to Shell Oil Company, 50 West 50th Street, New York 20, N. Y.,or 100 Bush Street, San Francisco 6, California.

SHELL VOLUTA OIL

SHELL

quency induction heat, the new furnace introduces a number of additional advantages through its design for bottom loading. A platform swings out for fast and convenient loading, then swings back beneath the furnace. At that point, a hydraulic lift goes into action, carrying the material up and into the furnace.

This type furnace can be operated at temperatures upward of 2500°C and under special atmospheres if desired, from existing or new equipment to meet a wide range of production requirements.

For further information circle No. 5

BRICK CUTTING TOOL

Time spent shaping refractories to size can be reduced by approximately 80% per brick, it is reported, with an inexpensive tool

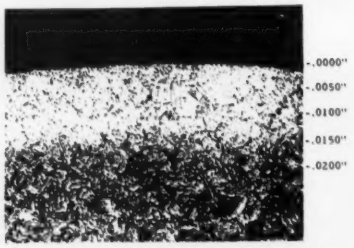
known as "Elmer's Little Helper". The announcement was made by E. & R. Manufacturing Company, Rochester, Indiana, originators of the non-hydraulic, portable masonry splitter that gives a sharp, saw-like break to masonry solids.

In addition to the time saving feature in end, angle and miter cutting, the hazards and irritations of flying dust, fragments, etc., are eliminated.

For further information circle No. 6

UNUSUAL CASE HARDENING

How heat treating with a special steel hardening compound creates case hardening that will not chip off was illustrated recently with photo-micrography at Hard-N-Tuff Corporation, Huntington, N. Y.



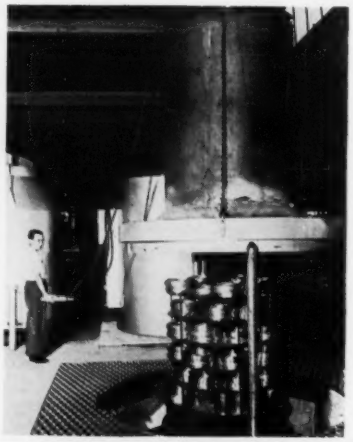
The photo disclosed that a graduated hardness gradient is formed, which produces a high resistance to chipping, as opposed to the sharp demarcation between case and core with ordinary carburizing or cyanide hardening.

The photo-micrograph shows a cross-section of ⅜" rod of 1015 steel after hardening with the Hard-N-Tuff, which carburizes, chromizes and nitrides in one operation. The test piece, covered with Hard-N-Tuff, was heated at 1600°F. for 15 minutes, then water-quenched. Case hardness of 65 Rc was secured at the surface, and is seen to penetrate .0144". Gradual blending continues to .0164", where the dense hard case is thoroughly integrated with the tough granular structure of the low carbon core.

For further information circle No. 7

FIXTURE FOR ANNEALING

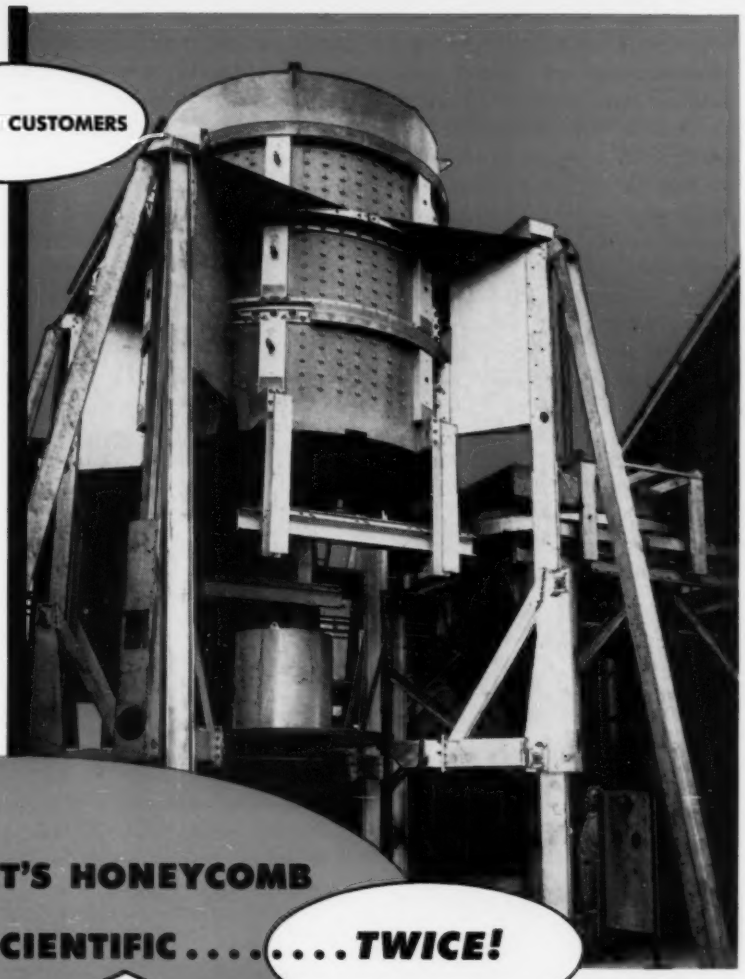
An open-sided annealing fixture, custom-made for use with a Bell type furnace, is permitting Handy & Harman, manufacturers of gold and silver alloys and solders, to realize important time savings and quality controls in the processing of wire coils.



Sound Familiar?
CARELESS MILFORD IS NOT PARTICULAR ABOUT THE PARTS HE SENDS IN FOR HEAT TREATING
BOY!...TAKE A LOOK AT THIS CASTING!
...OFF SIZE, NICKED, CRACKED AND WHAT HAVE YOU. HOW DID IT EVER GET OUT OF THEIR PLANT,...OR DON'T THEY CARE?
Justrite Heat Treating Co.

BUT... WHEN HE GETS THEM BACK... WHAM! LOOK WHO GETS THE BLAME!!!
CALL YOURSELVES METAL TREATERS? HAH! YOU SURE GAVE OUR CASTINGS THE 'TREATMENT'-THEY GO OUT OF HERE 100% PERFECT,...AND WHAT HAPPENS? DO YOU DROP 'EM OFF THE ROOF OR JUST RUN A TANK OVER THEM?..IF YOU HAVE NO CONSIDERATION FOR A CUSTOMER'S PRODUCT I'LL JUST HAVE TO...
HANK ROESLER

SECOND HELPINGS FOR SATISFIED CUSTOMERS



To withstand the severe service of aircraft and missile components, a combination of critical requirements is vital in brazing honeycomb materials.

This huge elevator furnace was built by Pacific Scientific to Solar Aircraft Company's specifications to meet these stringent requirements. *A second similar unit is now being built for the San Diego firm!*

Standing 35 feet high, this furnace is designed to come up to high temperatures fast and to operate with extreme uniformity of temperature.

Typical of many specially designed Pacific furnaces, this efficient elevator furnace has a heating chamber with an inside diameter of eight feet, and a depth of ten feet. Typical also is the smooth operation of the furnace door, which lowers and swings out of the way to provide fast cooling to set the braze, and also to allow swift, easy handling and loading.

SOLAR AIRCRAFT'S HONEYCOMB BRAZING GOES SCIENTIFIC....TWICE!

with this big, new

TRADE MARK Pacific elevator furnace

Whether your particular heat treating needs are for a giant, special furnace such as this, or for a small, standard-type box furnace . . . Pacific Scientific's advanced designs and construction techniques, backed by long experience, will pay off for you in most efficient, economical performance.

Pacific's heat treating engineers are always available to assist you in selecting the proper type and design equipment for your own particular job. For more specific information . . . call or write *today*.

BECOME A SATISFIED CUSTOMER ...MAIL COUPON TODAY!

Pacific **INDUSTRIAL HEAT TREATING EQUIPMENT**

PACIFIC SCIENTIFIC COMPANY
LOS ANGELES
SAN FRANCISCO
SEATTLE
PORTLAND, ORE.
ARLINGTON, TEX.

PACIFIC SCIENTIFIC CO. P. O. Box 22019, Los Angeles, California

Please send me bulletins and specifications on a Pacific Furnace for:

_____
(type of work)

Name_____

Company_____

Address_____

City_____ State_____

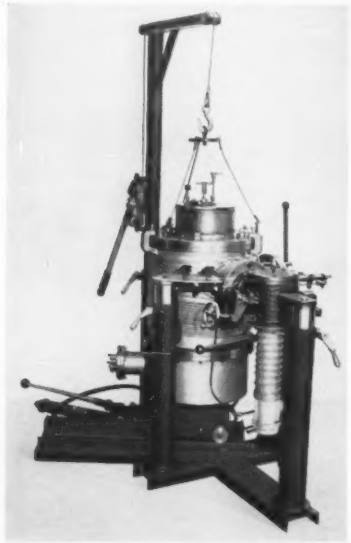
Handy & Harman engineers wanted a multi-tiered fixture. After sketching their rough estimates of what such a fixture would look like, they took the problem to the Wiretex Manufacturing Company, Inc., Bridgeport, Conn., manufacturers of heat treating baskets and fixtures.

The rack shown here that resulted from this planning is circular in design with six shelves of ¼" dia. perforated metal, $\frac{3}{16}$" thick. Steel rods, ¾" in thickness, are a reinforcing framework, joining together at the top of the fixture. The unit is open at the sides and has a loading capacity of approximately 2,800 pounds.

For further information circle No. 8

LABORATORY VACUUM FURNACE

A newly-designed Laboratory Vacuum Furnace capable of attaining temperatures in excess of 2000°C. has been announced by the Vacuum Equipment Division of The New York Air Brake Company. According to the manufac-



turer, this new F-9 Vacuum Furnace has a capacity of 10 pounds of steel or volume equivalent if the crucible is to be tilt-poured, and 25 pounds if bottom-plug pouring is employed.

The F-9 Furnace employs either resistance or induction heating and can handle either vacuum or inert gas melting and heat treating of metals including: melting, vacuum casting, annealing, sintering and crystal growing. A bulletin describing this furnace is available.

For further information circle No. 9

PORTABLE HARDNESS TESTER

A unique three-in-one portable Rockwell-type hardness tester is now being imported from England by G. A. Peabody Industrial Co. manufacturers and distributors of precision testing equipment.

Vertical, horizontal, and inverted tests are now possible with the same accuracy as laboratory bench-type machines. The instrument is entirely mechanical and records Rockwell A, B, and C values independently. Weighing less than three pounds, the instrument has a super-precision mechanism that is capable of recording accurately the tremendous magnification ratio between the diamond indentor and the linear travel of the indicator. The penetration depth of the indentor is less than 0.005 in. This minimum penetration feature insures mark-free testing of highly-finished and polished surfaces.

For further information circle No. 10

I.H.E.A. MEETING

C. Floyd Olmstead, President of Lee Wilson Engineering Company, Cleveland, Ohio was elected President of the Industrial Heating Equipment Association at its annual winter meeting in Pittsburgh, January 27 - 28, 1958.

R. L. Harper, Executive Vice-President of the Harper Electric Furnace Corporation, Buffalo, New York, was named Vice-President of the Association. Ralph E. Whittaker, Secretary and Treasurer of the Swindell-Dressler Corporation, Pittsburgh was re-elected Treasurer; A. E. Tarr, Assistant to the President, Leeds & Northrup Company, was elevated to the Executive Committee; and Robert E. Fleming was re-elected Executive Vice-President of the Industrial Heating Equipment Association.

New members of the Board of Directors include Carl F. Burling, Sales Manager, Lindberg Engineering Company, Chicago; Robert B. Hanna, General Manager, Industrial Heating Department, General Electric Company, Shelbyville, Indiana; and A. L. Hollinger, Vice-President, Surface Combustion Corporation, Toledo, Ohio.

Approximately seventy top executives of the industrial heating equipment industry attended the two-day session held at the Penn-Sheraton Hotel, Pittsburgh.

The theme of the convention was that of better business management, and round table discussions were held on pertinent subjects currently affecting the heating equipment industry.

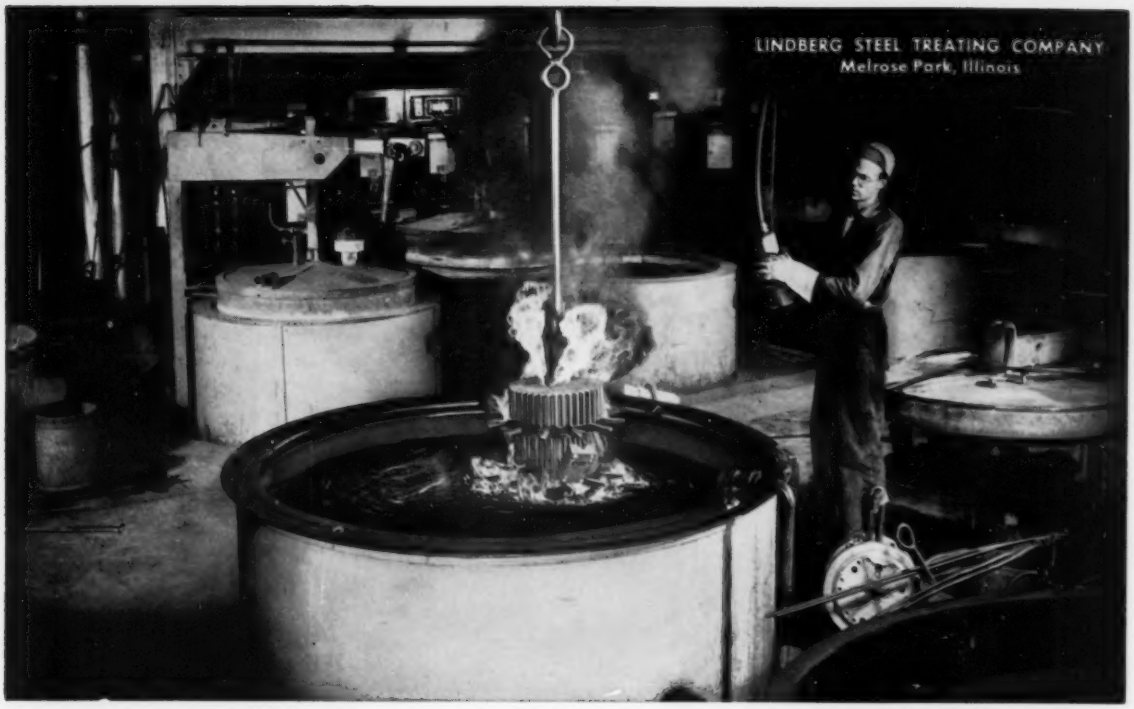
HEAT TREATING COURSE

"Heat Treatment of Steel," the second of a 39-course program of up-to-date specific courses in various phases of the metals industry is now available from the Metals Engineering Institute, a division of the American Society for Metals.

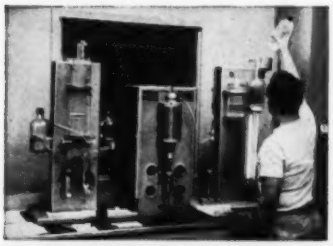
Prepared by George F. Melloy, Research Metallurgist at Bethlehem Steel Company, "Heat Treatment of Steel" begins with a three-chapter basic examination of what steel is and what steel does. Then, relating further material to these three lessons in fundamentals, the course takes up the details of various methods of processing steel. A chapter on tool steels completes the 15-lesson course.

The course is available on either

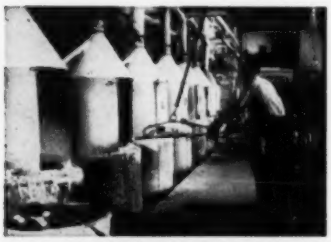
(Continued on page 32)



For machine shop tolerances— Lindberg uses Cities Service Quenching Oil



Lindberg's Lab stringently tests treated metals. Dimensional changes from poor quenching oil would quickly show up here. But Cities Service Quenching Oil cools metal with no significant dimensional change.



Some of Lindberg's Furnaces. Here, they heat-treat all kinds of steel products . . . bolts, washers, gear blanks, saw blade segments, etc. Steel for bars of Illinois State Penitentiary was one of their first jobs.

At Lindberg Steel Treating Company a routine order might include a dozen shafts, stamping and forming dies, jigs and fixtures and even production parts. But though the products might differ, most would carry the same stipulation—heat treat with very low dimensional change.

To some heat treating operations this might present a problem, but not to Lindberg. By the use of Cities Service Quenching Oil, they're able to cool their steel with no significant changes in dimension.

"In addition," say Lindberg metallurgists, "we like Cities Service Quenching Oil because it has high flash point, consistent viscosity, excellent oxidation resistance, and a stable cooling rate."

Anyone looking for a better quenching oil would do well to try this superior Cities Service oil. For further information, talk with your local Cities Service Lubrication Engineer. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

MAKE THE FACILITIES OF A COMMERCIAL HEAT TREATER YOUR METAL TREATING DEPARTMENT

An MTI commercial heat treater is located near you and is ready to serve your needs by performing "Custom-tailored" heat treating operations.

Because all members of the MTI are specialists with complete service facilities centralized in one plant, they are equipped to offer you a variety of heat treating processes—atmosphere hardening, carburizing, nitriding, annealing, cyaniding, etc.

For example, Fig. 1 shows an installation of a shaker hearth furnace with a continuous automatic quenching tank and a conveyor to a washing machine.

Fig. 2 illustrates a gas flame hardening unit featuring accurate temperature control and using two semi-circular gas manifolds mounted on movable carriages with 20 or more burner heads.

A further example of versatile and dependable equipment found in a commercial heat treating plant is seen in Fig. 3. The specially designed furnace conveyor belt carries over 35 lbs. per sq. ft. in normal service and sometimes as much as 5000 lbs. are loaded on it with pieces ranging from ½ lb. to 100 lbs. and temperatures up to 1650°.

Possessing such equipment together with many other specialized facilities and employing the trained personnel with technical knowledge and experience is the business of the commercial heat treater. Teamwork between him and the manufacturer can cut *your* costs.

Get in touch with the Metal Treating Institute or any MTI member listed on the facing page when you need heat treating services.

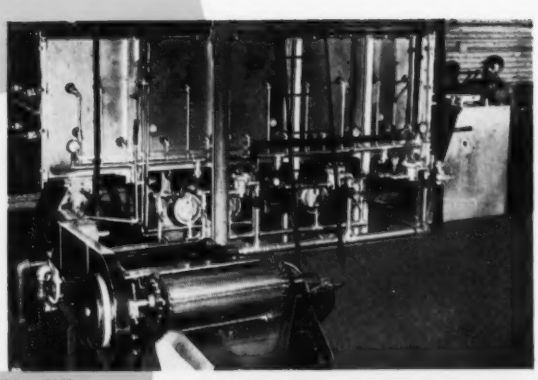


FIGURE ONE

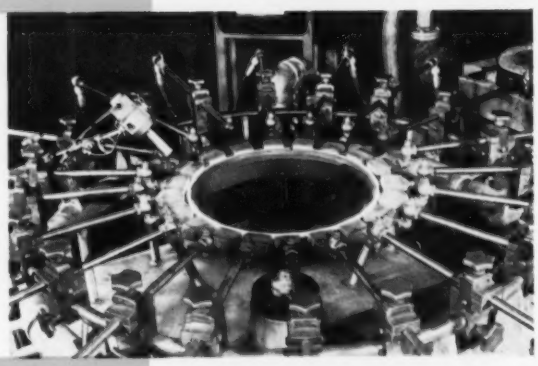


FIGURE TWO

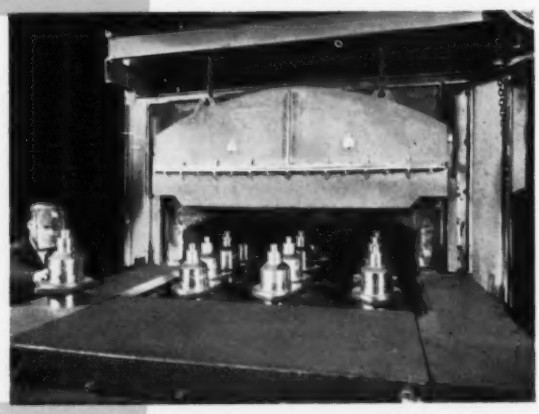


FIGURE THREE

METAL TREATIN

271 NORTH AVENUE • NEW

of these HEAT TREATING SPECIALISTS

CALIFORNIA

Certified Steel Treating Co.
2454 E. 58th St., Los Angeles 58
Hollywood Heat Treating Co.
6902 Santa Monica Blvd., Los Angeles 38
Lindberg Steel Treating Co.
2910 S. Sunol Drive, Los Angeles 23
Cook Induction Heating Co.
4925 East Slauson Ave., Maywood

CONNECTICUT

Commercial Metal Treating, Inc.
89 Island Brook Ave., Bridgeport 6
Stanley P. Rockwell Co.
296 Homestead Ave., Hartford 12

ILLINOIS

Senecca Heat Treating Co.
124 S. Batavia Ave., Batavia
Accurate Steel Treating Co.
2226 W. Hubbard St., Chicago 12
Allied Metal Treating Corp. of Illinois
333 N. California Ave., Chicago 12
Dura-Hard Steel Treating Co.
2112 W. Rice Street, Chicago 22
Pearson Industrial Steel Treating Co.
5757 W. Ogden Ave., Chicago 50
Perfection Tool & Metal Heat Treating Co.
1756 West Hubbard St., Chicago 22
Fred A. Snow Co.
1942 West Kinzie St., Chicago 22
American Steel Treating Co.
P. O. Box 225, Crystal Lake
Eklund Metal Treating, Inc.
721 Beacon St., Loves Park
Lindberg Steel Treating Co.
1975 N. Ruby St., Melrose Park
Ipsenlab of Rockford, Inc.
2125 Kishwaukee Street, Rockford
O. T. Muehlemeyer Heat Treating Co.
1531 Preston St., Rockford
C. U. Scott & Son, Inc.
1510 First Ave., Rock Island

INDIANA

Quality Steel Treating Company
1630 Locust Street, Anderson

MASSACHUSETTS

Kinetics Corporation
2 Churchill Road, Hingham
New England Metallurgical Corp.
475 Dorchester Ave., South Boston 27
Porter Forge & Furnace, Inc.
74 Foley St., Somerville 43
Greenman Steel Treating Co.
284 Grove St., Worcester 5

MICHIGAN

Anderson Steel Treating Co.
1033 Mt. Elliot Ave., Detroit 7
Bosworth Steel Treating Co.
18174 West Chicago Blvd., Detroit 28
Commercial Steel Treating Corp.
6100 Tireman Ave., Detroit 4
Commonwealth Industries, Inc.
5922 Commonwealth Ave., Detroit 8
Standard Steel Treating Co.
3467 Lovett Avenue, Detroit 10
Vincent Steel Process Co.
2424 Bellevue Ave., Detroit 7
State Heat Treat, Inc.
520 32nd Street, S. E., Grand Rapids 8
Lincoln Heat Treat, Inc.
21235 John R, Hazel Park
Metallurgical Processing Company
2703 East Nine Mile Road, Hazel Park
Royal Oak Heat Treat, Inc.
21419 Dequindre, Hazel Park
American Metal Processing Co.
12000 East Nine Mile Road, Van Dyke

MINNESOTA

Metallurgical, Inc.
900 East Hennepin, Minneapolis 14

MISSOURI

Metallurgical, Inc.
1727 Manchester Ave., Kansas City 8
Lindberg Steel Treating Co.
650 East Taylor Ave., St. Louis 15
Paulo Products Co.
5711 West Park Ave., St. Louis 10

NEW JERSEY

Ace Metal Treating Corp.
611 Grove St., Elizabeth 2
American Metal Treatment Co.
Highway 25 & LaFayette St., Elizabeth
Benedict-Miller, Inc.
Marin Ave. & Orient Way, Lyndhurst
Bennett Heat Treating Co., Inc.
246 Raymond Boulevard, Newark 5
L-R Heat Treating Co.
107 Vesey St., Newark 5
Temperature Processing Co., Inc.
228 River Road, North Arlington

NEW YORK

Owego Heat Treat., Inc.
Rural Route 1, Apalachin
Fred Heinzelman & Sons
138 Spring St., New York 12
Alfred Heller Heat Treating Co., Inc.
391 Pearl St., New York 38
Lindberg Steel Treating Co.
620 Buffalo Road, Rochester 11
Rochester Steel Treating Works
962 Main Street, E, Rochester 5
General Heat Treating Corporation
206 Sand Street, Syracuse 3
Syracuse Heat Treating Corp.
1223 Burnet Ave., Syracuse 3

OHIO

Queen City Steel Treating Co.
2980 Spring Grove Ave., Cincinnati 11
Ferrotherm Co.
1861 E. 65th St., Cleveland 3
Lakeside Steel Improvement Co.
5418 Lakeside Ave., Cleveland 14
George H. Porter Steel Treating Co.
1273 East 55th Street, Cleveland 3
Reliable Metallurgical Service, Inc.
3827 Lakeside Ave., Cleveland 14
Winton Heat Treating Co.
20003 Lake Road, Cleveland 16
Dayton Forging & Heat Treating Co.
2323 East First St., Dayton 3
Ohio Heat Treating Co.
1100 East Third St., Dayton 2

PENNSYLVANIA

Robert Wooler
Limekiln Pike, Dresher
J. W. Rex Co.
834 West 3rd St., Lansdale
Drever Company
220 West Cambria St., Philadelphia 33
Lorenz & Son
1351 N. Front St., Philadelphia 22
Metlab Company
1000 E. Mermaid Lane, Philadelphia 18
Wiedemann Machine Co.
4272 Wissahickon Ave., Philadelphia 32
Pittsburgh Commercial Heat Treating Co.
49th St., and A.V.R.R., Pittsburgh 1
Pittsburgh Metal Processing Co., Inc.
1850 Chapman Street, Pittsburgh 15

TEXAS

Dominy Heat Treating Corp.
P. O. Box 5054, Dallas
Superior Heat Treating Co., Inc.
P. O. Box 1686, Fort Worth 1
United Heat Treating Company
2005 Montgomery Street, Fort Worth 7
Cook Heat Treating Co., of Texas
6233 Navigation Boulevard, Houston 11
Houston Heat Treating Company, Inc.
2100 Quitman Street, Houston 26
Lone Star Heat Treating Corp.
5212 Clinton Dr., Houston 20

WISCONSIN

Allied Metal Treating Corp.
830 S. 5th St., P.O. Box 612, Milwaukee 1
Metal Treating, Inc.
720 South 16th St., Milwaukee 4
Supreme Metal Treating Co.
4440 West Mitchell St., Milwaukee 14
Thurner Heat Treating Co.
809 West National Ave., Milwaukee 4
Wisconsin Steel Treating & Blasting Co.
1114 South 41st Street, Milwaukee 15
Harris Metals Treating Co.
4100 Douglas Ave., Racine

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27 Bermondsey Road, Toronto 16, Ont.

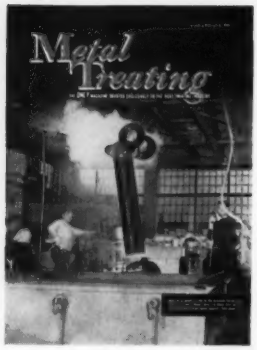
NSTITUTE

E, N. Y.

MASTER CRAFTSMEN
METAL TREATING INSTITUTE

Write for the MTI booklet called:
"PROCEDURES FOR PREPARING PARTS FOR HEAT TREATING"

The only magazine devoted exclusively to the Heat Treating Industry



If you sell

Heat Treating Equipment and Supplies

here are 4 basic reasons why

METAL TREATING *should*

be on your advertising schedule:

1. EDITORIAL CONTENT: All editorial effort is directed to the publication of the latest information on methods, techniques, new equipment and materials for the heat treating of metals and other related processes.

It is the quality of the editorial content which turns recipients into readers, and what you want to buy is readers.

2. READERSHIP: Editorial content strictly limited to audience interest and properly balanced with advertising content establishes reader acceptance. This is proved by the return of thousands of Readers' Service inquiry cards.

From the last 12 issues over 6,000 inquiries were received, making an average of over 500 inquiries per issue, or 15 per cent of the average circulation receiving these issues. *In addition over 300 "Letters to the Editor" constantly assure us of reader interest.*

3. CIRCULATION DATA: The controlled and BPA audited circulation reaches nearly 8,000 people — the important personnel who are engaged in some phase of heat treating either in heat treating departments of manufacturing plants or in commercial heat treating plants — all of whom buy your products.

The thoroughness and effectiveness of the coverage is evidenced by the fact that there are only slightly more than 6,000 plants employing more than 20, including commercial heat treaters, engaged in heat treating operations in the entire United States. *You do not pay for excess circulation.*

4. COSTS: An entire year's campaign (6 issues) of a one-page ad in color ($1,920.00) costs much less than fewer insertions in the majority of all other metalworking trade magazines.

Various reader surveys conducted by our advertisers themselves reveal that METAL TREATING is the lowest in cost per page per reader and ranks within the first five of trade journals read and preferred by the recipients of the questionnaires.

Write for our rate card and BPA Audit Report

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H. R. HERINGTON

Chairman, Publication Committee
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Metlab Co., Philadelphia, Pa.

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271 North Avenue
New Rochelle, New York
NEw Rochelle 6-4658

BPA

Member of Business Publications Audit of Circulation Inc.

HEAT TREATING HINTS

(*Continued from page* 14)

showed case depths of .012-.015" and hardness of 57-59 Rockwell "C." Samples had been drawn at 500°F., 600°F., and 650°F.—but the tooth failure still persisted.

Then Bill tackled the purchasing agent, Len Quigley, and the initial variation came out. Len had been unable to secure 4615—he had talked the matter over with Lou Greene, the Machine Shop Superintendent, and with the steeel supplier, and had decided that 4142 had the best combination of price, physical properties and ease of machining. They had successfully used it for other jobs, so without further research, the prints were changed and 4142 was substituted for the 4615.

Then the next problem arose—could the 4142 be retreated to give the necessary wear resistance and toughness on the ratchet teeth. Micro examination of the 4142 showed that carbonitrided ratchets had a course-grained, brittle case with rather high core hardness immediately under the case. The surface was very rich in carbides and austenite to a depth of .004-.005".

Old John volunteered to salvage the 10,000 ratchets. Samples were packed in a mixture of 50% spent carburizing compound and 50% pitch coke, reheated to 1450°F. and oil quenched, drawn 450°F. to 58-60 Rockwell "C." Tests proved satisfactory even though the hardness was a point or two higher!

But Old John strongly advised a return to AISI-SAE 4615 or something similar. For the section involved in the ratchets, AISI-SAE 4142 was much too high in hardenability and produced too high core hardness with consequent brittleness. Old John was thinking of the truism that said: "As the case and core hardness approach each other, the need for carburizing (or carbonitriding) diminshes."

We know, however, of some applications which employ carbonitrided or cyanided medium carbon steels and the purpose for which is to provide a file-hard, wear-resistant surface which cannot ordinarily be provided by the base analysis. Parts so treated, however, are generally not subject to impact loading.

Free machining 8620 was substituted for the 3615 and 4142, and the next batch of ratchets came through without failure.

Source—HEAT TREATING HINTS, Vol. IX, Nos. 7 & 8

Making Provisions—**"There is no royal road to progress. There is no short-cut to the abundant life. But by mobilizing our man-power and scientific resources we can provide for an expanding and vigorous economy. There is always work to be done as long as human wants are unsatisfied."**—***Nicholas E. Peterson, Vice President, First National Bank of Boston.***

HAMLER

FIRST with 99.999% PURE METAL TREATING GRADE ANHYDROUS AMMONIA

Hamler Industries, Inc. is still in the lead with another FIRST !!!

Our total requirements of Anhydrous Ammonia are now being supplied with a new and purer grade never before offered to the Metal Processing Industry.

Hamler is the only distributor to Industry being supplied with Metal Treating Grade Anhydrous Ammonia of the following unsurpassed specifications:

Purity	99.999% Minimum by weight
Moisture	0.001% Maximum
Oil	2 PPM Maximum

OTHER HAMLER "FIRSTS" TO INDUSTRY

FIRST to specialize in a Service offering only one high grade purity Ammonia.

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FIRST to reduce Ammonia costs.

FIRST distributor of Ammonia with adequate bulk storage plants to give prompt and efficient service.

Discover what Hamler Service can mean to you —call or write one of our offices for complete information.

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BULK PLANTS

CHICAGO CLEVELAND PITTSBURGH
DETROIT DAYTON

NEWS TO HEAT TREATERS

(*Continued from page* 26)

an individualized home-study basis or to training directors and other administrative personnel wishing to use it for on-the-job or in-plant training.

For further information circle No. 11

NEW MARKER FOR HEAT-TREATING

Making positive identification always possible is a marker for any type metal whose markings withstand 2400°F. Developed by the Markal Company, Chicago, it is called the "Markal M-10 Paintstik Marker," and is said to be ideal for heat treating, normalizing, annealing and butt-weld tube marking.

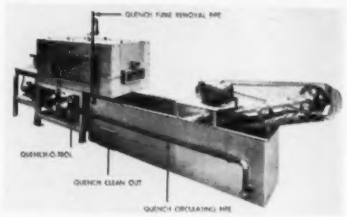
The parts or surfaces to be identified are marked with "M-10" while cold, and, it is said, the marks remain highly visible and legible regardless of the amount of heat up to 2400°F. Furthermore, they easily withstand quenchings in oil or water. One of a number

of "Paintstik" formulations for particular applications, this product contains no lead, zinc or copper pigments, and can be safely used on such metals as Stainless Steel, Titanium and Zirconium. The "M-10" marks can be removed if desired through use of a pickling bath.

For further information circle No. 12

SHAKER HEARTH FURNACE

Hevi-Duty Electric Company has announced a new high temperature shaker hearth furnace for bright carburizing, cyaniding, and hardening at temperatures to 1900°F. This new furnace is available in three standard sizes with capacities in pounds treated per hour of 15 to 35, 35 to 75, and 75 to 150.



A Quench-O-Trol unit will be supplied where exacting temperatures must be maintained in the quenching oil. A salt bath quench can be supplied for martempering or austempering parts upon discharge from the furnace.

For further information circle No. 13

AIR AND GAS DRYING

C. I. Hayes, Inc., of Cranston, R. I., a pioneer in controlled-atmosphere (Certain Curtain) electric heat treating equipment, announces a completely new concept in equipment for air and gas dry-

General Alloys' Radiant Tube Assemblies combine castings and fabrications to obtain the best features of each for optimum performance and service life.

The cast return bends give uniformity and extra strength at the area usually susceptible to early failure. The fabricated straight sections are light weight and provide maximum efficiency for heat transfer.

General Alloys combination cast and fabricated Radiant Tube Assemblies are available in many types of heat and corrosion resistant alloys, in a wide range of shapes and sizes to meet your specific requirements.

Special design combines casting and fabrication for maximum service life and efficiency

Extensive experience in high alloy castings and fabrications, together with modern production and testing facilities, is your assurance of superior results and satisfaction.

Call or write for detailed information or quotes.

General Alloys

General Alloys Company • Fabricated Alloy Division

403 West First Street, Boston 27, Massachusetts

Offices in Principal Cities

Specialists in high alloy castings and fabrications for 37 years

ing. Known as the Molecu-Dryer, the unique design concept of this unit utilizes super-induced conduction to obtain continuous operation without the use of blowers, heat exchangers, or separate purge gases.

High temperature drying to dew points of minus 100°F or better are possible through the drier built to utilize the superior absorbent properties of Linde Molecular Sieves, recently developed by Linde Air Products Company, a division of Union Carbide and Carbon Corporation.

For further information circle No. 14

SIX-TON ROTOBLAST BARREL

Pangborn Corporation, manufacturers of blast cleaning and dust control equipment, has introduced a new 72-cu. ft. Rotoblast barrel to blast clean loads of castings, forgings and heat-treated parts weighing up to 6 tons (see cut). Designed for foundries, forge shops, heat-treating plants and other metalworking factories which clean and descale heavy parts in large volume, the new 72-cu. ft. barrel was developed to provide a high-capacity, heavy-duty machine, with low maintenance and operating costs.

Believed to be the world's largest blast barrel manufactured, the new unit will clean a 6-ton load of castings in five minutes. The 72 Type GN barrel is 21 ft. 5 in. wide by 10 ft. 11 in. deep by 23 ft. high.

For further information circle No. 15

NEW REPRESENTATIVE

Heatbath Corporation announces the appointment of Mr. Robert G. Wild of 873 Roanoke Road, Cleveland Heights, Ohio as representative for the northern Ohio and

QUALITY and COST CONSCIOUS MANUFACTURERS choose - "AGF Reciprocating Furnaces" for their production heat treating —

Automatic continuous flow operation reduces work handling costs and improves quality.

Full flexibility to handle the widest range of work without any modification (pen points to forgings) with any desired atmosphere. There's no distortion with the "shaker hearth" work conveying system and continuous individualized quenching.

AMERICAN GAS FURNACE CO. 80 YEARS OF PIONEERING 1878 1958 ELIZABETH, N. J.

AGF Reciprocating Furnaces with automatic feeding and automatic quenching are continuous flow machines that can be operated as integral automatic heat treating installations or they can be incorporated into your plant production line.

There are standard AGF Reciprocating Furnaces to meet your heat treating requirements.

Investigate the cost saving potential in your plant by writing today for engineering and metallurgical recommendations at no obligation.

AMERICAN GAS FURNACE CO.

808 LAFAYETTE STREET — ELIZABETH 4, N. J.

"Pioneers since 1878"

western Pennsylvania area.

Mr. Wild was formerly with the R. O. Hull Company and R. W. Renton Company, both of Cleveland. He is a graduate of Western Reserve and is very active in the Cleveland Chapter of the A.E.S.

SALT BATH FURNACE

Lucifer Furnaces, Inc., of Neshaminy, Pennsylvania, has announced a new series of salt bath furnaces. The series is said to prevent oxidation, scaling and decarburization while operating at peak production with unskilled labor. There are 10 sizes available with heat ranges to 1700°F. Rapid constant heat, ease of installation, minimum replacement down-time and low maintenance costs are the features stressed by the manufacturer. All models are complete with controls.

For further information circle No. 16

NEW GENERAL MANAGER

A recent announcement from the Sunbeam Corporation mentions the appointment of Mr. V. R. Troglione as the new General Manager of the Industrial Furnace Division with headquarters at 4433 West Ogden Avenue, Chicago 23.

TOOL STEEL SUPERVISOR

Crucible Steel Company of America has appointed Robert F. Spillett to the newly created position of New England Tool Steel Supervisor.

Located at the company's Boston sales branch, 129-135 Binney Street, Cambridge 42, Mass., Mr. Spillett will aid the Crucible salesmen in providing better service.

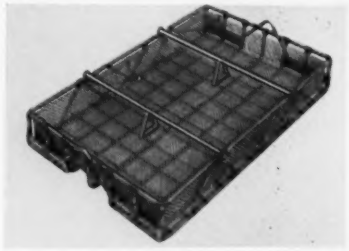
HEAT TREATING WALL CHART

The Industrial Furnace Division of Sunbeam Corporation has issued a wall chart listing all SAE steel specifications for carbon steels, free-cutting steels, manganese, nickel, molybdenum, and chromium steels, and various other metal groups. Additional information is also given concerning typical heat treatments for SAE steels.

For further information circle No. 17

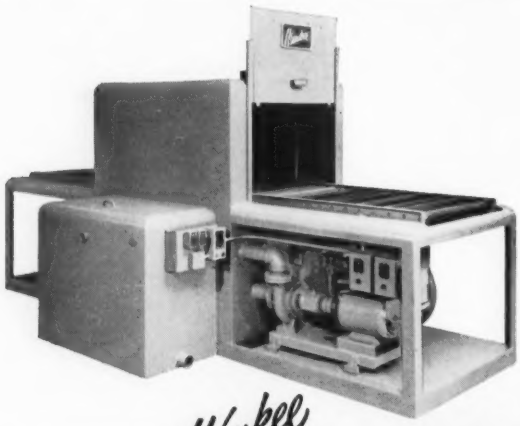
FURNACE TRAY PATENT

Rolock, Incorporated of Fairfield, Connecticut has recently been granted U.S. Patent No. 2807454 covering design and construction features of furnace trays for Ipsen, Lindberg, Eclipse and other furnaces having a similar type of flat hearth.



Trays of this improved design

(*Continued on page* 40)



There's a standard Waukee® WASHER

TO MATCH YOUR CARBONITRIDER OR CARBURIZER!

Whatever the size of your carbonitrider or carburizer, the new Waukee Washer has a standard size to match it. Size range: 24 x 36 x 18 — 24 x 48 x 24 — 30 x 48 x 24 — 36 x 48 x 24.

COMPLETE — NO "EXTRAS" — Waukee parts washers come to you complete, ready to locate, connect to utilities, and begin operation. No "extras" to buy and install. Pumps, burners, controls are designed as integral parts of the Waukee Washer. You use your present furnace work-baskets, too.

FLEXIBILITY — You gain in flexibility with Waukee Washers. Standard units are available in "in-and-out" feed or straight-through, conveyor type, and in one, two, or three stages with rinse and dry. High-efficiency with gas, electricity, or steam.

THOROUGH CLEANING — The smallest Waukee Washer sprays a minimum of *one ton of hot detergent solution through the load each minute.* Solution penetrates work basket from top and bottom, washes away oil and foreign matter from the densest charge. Bull's-eye timer cycles the load for complete washing without guesswork or waste of time.

Complete data in Bulletin 1201 — write for it today.

Waukee-washed parts are free of cutting and quenching oils, mean clean furnace atmospheres, therefore predictable case depths and cleaner, brighter work.

Waukee ENGINEERING CO.

5137 N. 35TH ST., MILWAUKEE 9, WIS.

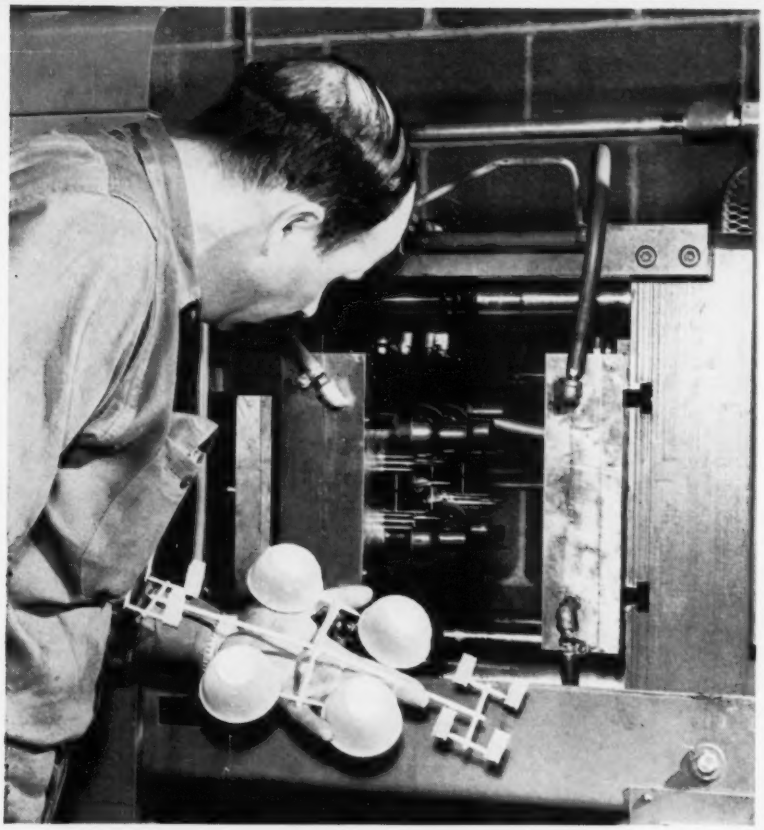
MAKERS OF WAUKEE GAS FLO-METERS • MIXORS • COMPRESSORS

Tool Steel Topics

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation



For long runs and high polish they molded bowls with Lustre-Die

Our local tool steel distributor, Ford Steel Co., St. Louis, answered the question frankly. "If you're looking for high sheen on the finished product," they said, "and want a long-lasting die as well, we recommend Lustre-Die."

The die manufacturer, Lambert Engineering Co., St. Louis, put Lustre-Die to the test. They prepared the dies to produce plastic bowls used in a popular blender, for Chris Kaye Plastics Manufacturing Co., Madison, Ill. The result? Excellent die performance, and a fine looking product as well.

Lustre-Die is a really top-grade tool steel for making plastic parts because it has the properties which enable it to take an unbelievably bright polish. Lustre-Die not only has the proper basic analysis for working with plastics — we further improve it by alloy fortification, increasing its depth of hardenability and mechanical properties. It is heat-treated by oil-quenching and tempering, and is furnished ready for machining and polishing.

Lustre-Die is carefully made in the electric furnace. It undergoes close inspection to insure cleanliness. Moreover, it is free from injurious porosity or surface pitting.

Any way you look at it, Lustre-Die is fine tool steel, and a good performer. If you would like full information, check with your Bethlehem tool steel distributor.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

There's No Scorch With Proper Grinding

The redressing of worn tools by grinding is often done improperly. This causes a lower service life after regrinding than on the original grind.

The most common error in regrinding tools is the removal of metal so rapidly that the heat generated causes a "tempering back," or softening of the steel in areas which have been ground. Thus, the reground tool is softer in the working areas than it was originally, and therefore wears more rapidly. Abusive grinding is almost always accompanied by scorching, which produces purple, blue and yellow temper colors where the grinding has been done.

Many operators realize that the appearance of scorching is an indication of improper grinding, and they therefore make it a point to remove the scorched areas with a final, light grinding pass. This removes the visible evidence of scorch but does not remove the harmful effects. Tools which are being properly ground do not develop scorch in grinding.

USE CROMO-WV DISCS TO EXTRUDE ALUMINUM

This Bethlehem upset-forged disc, to be used in extruding aluminum, is made of Cromo-WV Hot-Work tool steel. Cromo-WV makes possible increased production of aluminum extrusions because it is resistant to heat-checking, and has adequate wear-resistance and toughness. Cromo-WV also responds accurately to heat-treatment. It's good tool steel — worth ordering for your next extrusion job.

Everybody profits ...because **you belong** *in this picture!*

The publisher of this magazine is often asked what kind of a man you are . . . and how many like you are receiving his magazine.

Why is he asked?

Because the *advertisers* (whose money is his chief income) insist upon knowing the types of people (by industry or profession, by title) for whom the magazine is edited — and how many are getting it.

In order to standardize on the presentation of such information to advertisers and to have its accuracy vouched for by a disinterested third party, nearly 450 publishers have joined some 200 leading advertisers and advertising agencies in a non-profit organization called Business Publications Audit.

The purpose of BPA is to assure advertisers . . . by frequently checking and rechecking . . . that each member publisher is indeed distributing his magazine, in the *numbers* promised, to the *types* of men he promised would receive it.

The BPA symbol in this magazine means that *you belong* . . . that because of your occupational interests you are qualified, in the eyes of the advertisers, to receive it.

The advertiser can thus tell whether he's getting his money's worth.

The publisher has a better sales story to prospective advertisers because his magazine is "audited."

And you, the reader, get more value from the magazine because both the advertisers and editors, knowing what your special occupation is and what your interests are, are better able to prepare advertising and editorial material that will be most informative and useful to you.

What you can do

Publishers and advertisers frequently write to magazine readers to learn what kind of articles and advertisements appeal most. Cooperate with them — will you? — by answering their questions . . . in the interest of better communications between makers and markets.

BUSINESS PUBLICATIONS AUDIT OF CIRCULATION, INC.

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BPA

A NON-PROFIT, TRIPARTITE MEMBERSHIP CORPORATION OF ADVERTISERS, ADVERTISING AGENCIES AND BUSINESS PUBLICATIONS

Here's Proof that Park AAA Gives QUICK-QUENCHING Action!

Inspecting the dramatic action of Park Chemcal's AAA quench oil are (l. to r.): Harold F. Wagner, Service Metallurgist, Commercial Steel Treating Corp.; Wm. Askew, from Park's Detroit office; Anthony J. Beck, Chief Engineer, Commercial Steel Treating Co.; and Merle Hoensheid, Plant Manager, Commercial Steel Treating Corp.

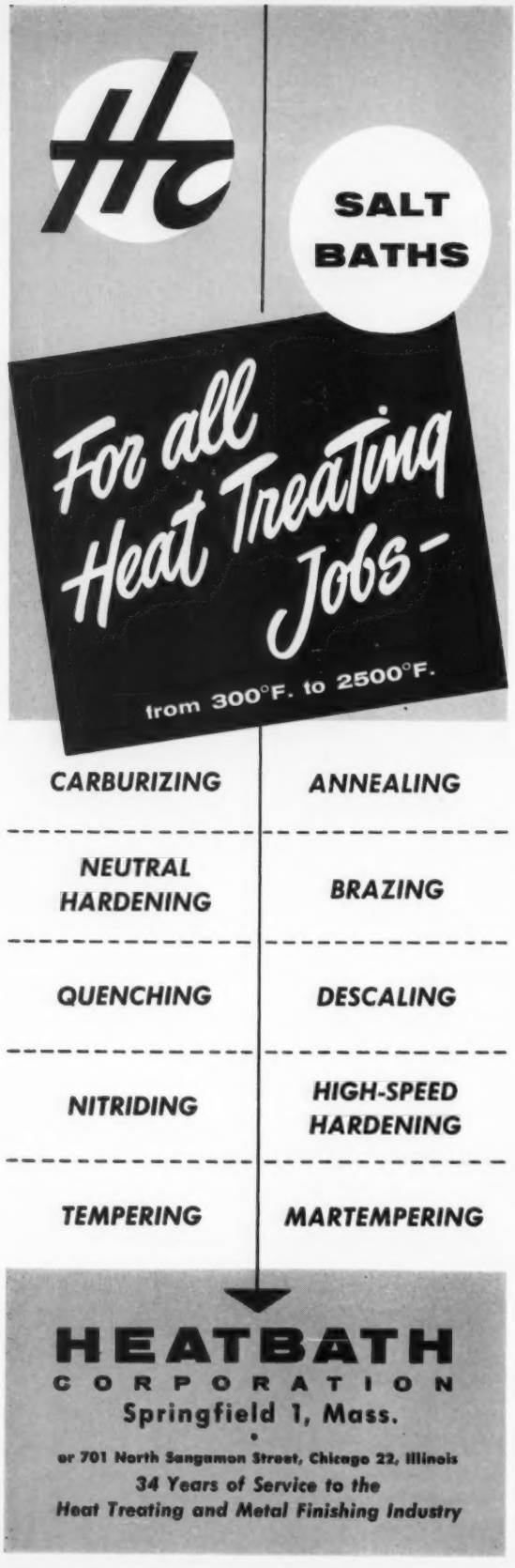
Here you see the dramatic action of Park Chemical Company's AAA Quench Oil, a faster cooling yet extremely long-lasting quench oil. Park AAA provides higher and more uniform hardness, with little or no distortion, warping, or cracking. To quote Merle Hoensheid, General Manager of the Stephenson Highway plant of the Commercial Steel Treating Corporation, Detroit: "We have learned to *depend* on the more than satisfactory results from Park's AAA quenching oil."

Park Chemical produces a complete line of heat treating materials bearing the same high quality and dependability of Park's AAA. Highest quality and uniformity are absolutely maintained in *all* Park heat treating products through strict laboratory control from raw material to finished product.

We would be happy to help you work out a solution to your heat treating problems without obligation. Call or write today.

Woodside Rapid Carburizers (Non-Burning—Charcoal-Coke-Specification) • Park-Kase Liquid Carburizers • Quenching and Tempering Oils • Cyanide Mixtures • Neutral Salt Baths • High Speed Steel Hardening Salts • Iso-Thermal Quenching and Tempering Salts • Protective Coatings (No-Carb—No-Kase—No-Scale—No-Tride) • Carbon Products (Charcoal-Crushed Coke-Pitch Coke-Lead Pot Carbon) • Kold Grip Polishing Wheel Cement • Par-Kem Metal Cleaners • Cutting and Grinding Compounds (Kem-Cut—Kem-Grind—Blue Ice)

Park **PARK CHEMICAL COMPANY** • 8074 Military Ave. Detroit 4, Mich.



SALT BATHS

(*Continued from page* 9)

are the main mischief makers. The extent of breakdown can be readily and easily determined by the method outlined above.

The various heat treating operations carried out within the range 1250-1850°F., whether in a gas-fired or electric salt bath furnace, may be briefly enumerated as annealing, stress relieving of ferrous and non-ferrous metals (including silver and gold alloys), aluminum and silver brazing, hardening of carbon steels, air hardening steels and stainless steels, carburizing low carbon steels, and austenitizing for ausquenching or marquenching.

Starting an electrode furnace with a ceramic pot, it is desirable to preheat the pot with an idle gas flame for 4-6 hours to drive off any moisture at and around the cemented points and to avoid thermal shock to the ceramic bricks. This will contribute to a longer pot life. Such pots have an expected life of 2 to 3 years at 1550°F. and 1 to 1½ years at 1850°F. Electrodes would last 1 to 2 years at 1550°F. and 1 to 1½ years at 1850°F.

III. High Temperature Range—(1850°-2350°F.)

A. Salt Baths:

This is the most critical range, and chemical reactions are extremely fast. The dangers of pitting, decarburization or fusion are great. Conditions need to be as perfect as humanly possible. Ordinary salt compounds are too unstable to be usable at these temperatures. Any salt or compound to be satisfactory at these temperatures has to be:

(1) Neutral to the steel as well as to the ceramic pot;
(2) Completely molten and liquid within this operating range;
(3) Water soluble and easily washable;
(4) Of sufficient electrical resistance to generate heat in an electrode furnace; and
(5) Very stable to maintain its neutral reaction to steel at 2350°F. There is no salt or chemical that meets fully all these desirable and necessary requirements. A salt that is perfect in one respect is not altogether satisfactory in another. Our choice is limited to very few chemicals and at the best it is a compromise.

Chemical Compounds

The most commonly used chemical within this range is barium chloride. This salt melts at around 1700°F. and is liquid above 1750F.° At 1850°F. it begins to break down slowly, and as the temperature increases, the rate of break down also increases. To insure its neutrality, that is, to be sure it will not decarburize, certain rectifiers are incorporated in it. These rectifiers may be silicon dioxide, titanium dioxide, boric acid, molybdenum dioxide, zirconium tetrachloride and molybdenum silicide. One or more of these rectifiers are added in proper quantities to

react with the broken down salt to neutralize it before it has a chance to decarburize the tools. These rectifiers are often packaged separately to be added to the bath whenever correction is needed. Excessive addition of rectifiers should be avoided because they may introduce other complications such as increasing the viscosity of the bath, generating excessive sludge and reducing washability.

Another compound used within this range is a fused mixture of borax and boric acid. This is the first salt bath used in this country for the hardening of high speed steel tools. It was developed by Major Arthur Bellis, Founder of The Bellis Company, in 1918, and was used by a number of tool manufacturers for nearly 35 years. Its main shortcomings were: (1) it could only be used in a specially designed fuel-fired furnace; (2) the mixture as fused, being a borax glass, was not too easy to wash off the tools; and (3) it had, particularly when fresh, great capacity to dissolve steel, often causing size change in tools that could not be ground after hardening. As the salt was used repeatedly and became old, this particular tendency decreased; hence a proper balance had to be kept by adding fresh salt to the old one.

With the advent of the electrode-type furnace, the boric acid, borax mixture gradually lost ground and at the present time it is practically in the discard. It is only mentioned to complete our review and because it had for many years contributed with all its shortcomings to the hardening of high speed steels.

The third type of a salt bath compound is a synthetic mixture of sodium, potassium and calcium silicates. Such a mixture, although not used commercially at the present time, is the most stable compound known to the author. Because of this stability it remains neutral indefinitely. During a series of experiments a large number of high speed tools processed through such a bath did not even discolor; and as a result, it was difficult to distinguish heat treated tools from the untreated ones just by appearance alone. Although this mixture has a great possibility, its main drawback has been the difficulty of washing off the salt. Being a silicate glass, it is not water soluble, and this feature has prevented its extensive use. Additional research along this line may be worthwhile and rewarding.

The chemical test method to check up the bath for breakdown or alkalinity was described previously. For safe and satisfactory results the alkalinitv as indicated by tenth normal hydrochloric acid should not exceed 3 cc and preferably less. If it should exceed 3 cc, a rectifier should be added, about one ounce for every 100 lbs. in the pot. Since a clean salt bath is essential to obtain clean work, it is necessary to desludge the pot regularly, once or sometimes twice a week. This will prevent accumulation of sludge in the bottom which may harden and reduce the effective depth of the pot. It is much more economical not only to de-

(Continued on page 52)

MODERNIZING?

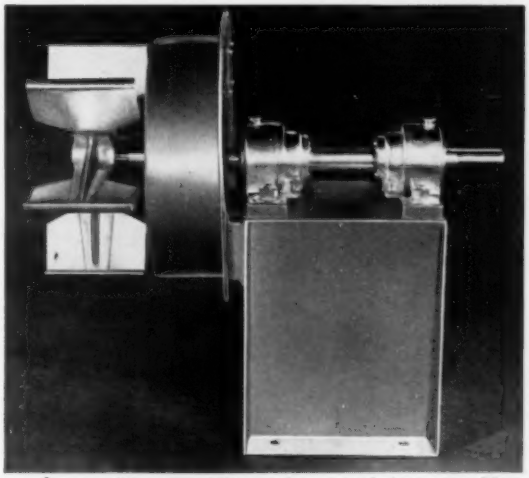
The NEW Radial Blade

PLUG TYPE UNIT BY

GARDEN CITY FAN

(for temperatures up to 1650°)

cuts costs because it eliminates duct work



Plug type unit can be mounted in any position

Costs less initially, costs less to install, costs less to maintain! Yet if you want to convert to a standard insulated fan at a future date you can . . . merely by application of housing. This fan has the famous Garden City patented AIR COOLED SHAFT to prolong the life of your bearings. This plug type unit is for new or existing furnaces or ovens.

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Costs are low and predictable with pressed steel pots!

When you buy a cast steel or alloy pot, you can never really know what the ultimate cost may be. Any cast pot can have a concealed flaw capable of causing sudden failure *at any one heating*. The result — major equipment repairs!

Eclipse Pressed Steel Pots cost only one-third as much as cast pots, initially — and *cannot turn suddenly defective!* No defective steel survives the stresses of drawing. Switch to pressed steel pots and you switch to *scheduled* pot maintenance that puts your profits on a *predictable* basis. What's more, Eclipse pots *weigh only half as much* and have higher thermal conductivity! That means substantial fuel savings and faster, better controlled heating.

Eclipse Pressed Steel Pots are formed from highest quality firebox open-hearth mild steel, from the heart of the ingot, with a perfectly uniform 3/8-in. section. They're practically impervious to corrosion. Write for illustrated catalog and price list — 78 standard pots available immediately from stock! For lead, salt, cyanide, oil tempering, metal melting.

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20 Upjohn Road, Don Mills, Ontario

Eclipse® INDUSTRIAL COMBUSTION DIVISION

MTI ACTIVITIES

(Continued from page 20)

SOUTHWESTERN METAL CONGRESS

Twenty - eight technical papers will be presented before the ASM Southwest Metal Congress to be held in Dallas, Texas, May 12-16.

The Metal Treating Institute and its new Texas Chapter are participating in this Congress by jointly sponsoring a paper to be delivered on Tuesday, May 13th, on the subject "The Practical Applications of the Tempering Parameter Technique for 410 and 416 Stainless Steels" by Charles F. Lewis, Metallurgist for the Cook Heat Treating Company of Texas.

NEWS TO HEAT TREATERS

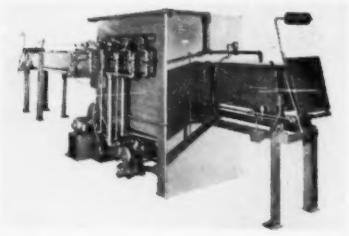
(Continued from page 34)

are said to offer easier handling in and out of the furnace; better support and prevention of side-slide when stacked two-high; a generally higher live-load to basket weight ratio and substantially increased furnace-hour life expectancy.

For further information circle No. 18

HYDROGEN ATMOSPHERE FURNACE

A new line of gas-fired hydrogen atmosphere furnaces, with heating chambers up to 14" wide by 48" long by 10" high has been developed by Eclipse Fuel Engineering Co., Rockford, Illinois. These full-



muffle, pusher-type furnaces are designed for bright brazing, annealing, and hardening of stainless, tool, and carbon steels without oxidation or discoloration.

For further information circle No. 19

Far Faster...
Lower in Cost...
Improves Quality

by providing sound, uniform, close-tolerance brazes

Complicated aluminum tube "nests" (like this) are brazed fast and economically in this Ajax installation in a well-known California plant

DIP BRAZING OF ALUMINUM ASSEMBLIES Gives Production a Big Boost

Even highly complicated aluminum assemblies can be handled better and faster . . . on a mass production basis . . . in inexpensive Ajax Salt Bath Furnaces engineered for maximum efficiency on your particular application.

Costs are reduced and brazing quality materially improved. All joints are brazed quickly and simultaneously. Distortion is negligible. Polished aluminum surfaces offer no problem. Extremely close temperature control eliminates the possibility of overheating.

Write for Ajax Case History Bulletin

Do you get "Salt Bath Tips & Trends"?

Chock full of valuable heat treating information, this little Ajax house organ is issued four or five times each year. A note on your company stationery will put you on the list to receive it.

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SALT BATH FURNACES

Internally heated. Electric and gas fired types.

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Affiliates: Ajax Electrothermic Corp., Ajax Engineering Corp.

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MANUFACTURERS' LITERATURE

For your copy circle the number on the Readers' Service Card

REFRACTORIES BULLETIN

A recently completed bulletin by the Denver Fire Clay Company covers a variety of high temperature refractory bonding mortars. Seven types cover all possible requirements and are described in this bulletin.

For further information circle No. 22

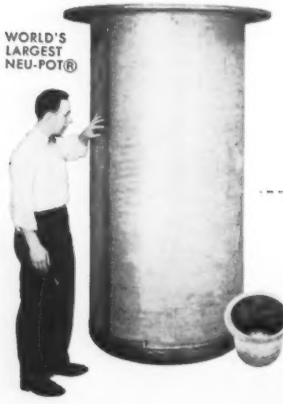
INERT GAS GENERATOR

The Sub-X line of Inert Gas Generators is now available from Thermal Research & Engineering Corp. of Conshohocken, Pa. This generator utilizes direct contact cooling of the products of combustion from the burner.

For further information circle No. 23

ROLOCK

FABRICATED HEAT AND CORROSION RESISTANT ALLOYS



Thousands of furnace hours PROVE... there's no pot like a ROLOCK NEU-POT®!

ROLOCK NEU-POTS® now stand *proved* by tens of thousands of hours of use under all kinds of operating conditions and by a growing list of satisfied customers.

More often than not, the longer service life of NEU-POTS® compared to other pots can be measured in months instead of weeks... thousands of hours rather than hundreds. NEU-POTS® can be *expected* to show substantially lower furnace-hour costs in any neutral salt bath installation.

The "secret"... and there is one... lies as much in how NEU-POTS® are made as in what they are made of. Inconel welded fabrication has, indeed, proved just about ideal for this type of service. However, ROLOCK brings years of technical know-how in working with high heat-resistant materials to NEU-POT® design and fabrication, including final X-ray test. It will pay you to replace with genuine trade-marked ROLOCK NEU-POTS®.

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Easier Operation, Lower Cost

HEAT RESISTANT CASTINGS

Marking the completion of a ten-year compilation and research project, a set of data sheets giving the most up-to-date property information available on the heat resistant cast high alloys has just been published by the Alloy Casting Institute, association of high alloy foundries.

Central feature of the new data sheets is a listing of room temperature and elevated temperature properties of each of the cast heat resistant alloy grades. In addition to specific property data, each of the 14 sheets gives a concise discussion of the applications, design and fabricating characteristics of each alloy.

For further information circle No. 24

HEAT EXCHANGER LINE

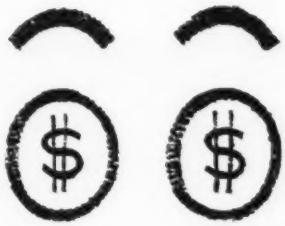
Announcement has been made that a complete line of heat exchangers is being produced by Yates-American Machine Company of Beloit, Wisconsin. Following the introduction of fixed bundle shell and tube heat exchangers a year ago, the Company began enlarging its heat transfer facilities to include the design and production of steel and copper shell removable bundle heat exchangers, and fixed bundle aftercoolers and separators. A bulletin gives specifications and applications.

For further information circle No. 25

STAINLESS DATA

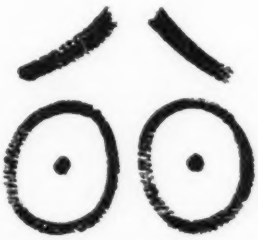
A Blue Technical Data Sheet on a special stainless steel that is used for jet engine parts, high pressure steam valves, and steam and gas turbine parts is now being distributed by Allegheny Ludlum Steel Corporation.

For further information circle No. 26



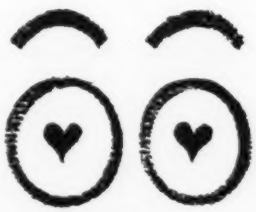
February—Bought lower grade ammonia at a bargain price . . .

Later—Discoloration of finished parts apparent, rejects more frequent, pickling necessary . . .



Still later—Oil! Pressure regulators clogged, catalyst poisoned, incomplete dissociation . . .

Too late—Shut down metal treating line for repairs . . .



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Such consistent purity, dependable delivery service from 163 stock points and 8 bulk stations—and a technical service that's second to none—make Armour your one best source for trouble-free ammonia. For further information and a copy of the informative Dissociated Ammonia booklet, write us on your company letterhead.

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HEAT TREATING TECHNIQUES IMPROVED AT RIVERSIDE FOUNDRY

Illustrated above is the Hevi Duty Furnace used to determine heat treating procedure and the metallurgical characteristics of new alloys or special steels, at Riverside Foundry in Bettendorf, Iowa. The establishment of the proper time and temperature cycles for the treating of various castings has increased production while reducing rejects.

Engineered features that produce the heat treating results you want

Only Hevi Duty Furnaces assure uniform temperature with the long life "Return Bend" heating elements that radiate the heat from the six sides of the work chamber. Ceramic refractories rigidly support the round rod elements which have proven durable under the most severe operating conditions. Because the Return Bend Elements have less surface area per cross-section to oxidize or deteriorate, element life is greatly increased.

There is a Hevi Duty Furnace in the size, type, and temperature range to handle your most critical type of heat treating. Tell us about your requirements.

Write for Bulletin 441.

HEVI DUTY ELECTRIC COMPANY

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Heat Treating Furnaces... Electric Exclusively

Dry Type Transformers *Constant Current Regulators*

CARBURIZING COMPOUNDS

A bulletin published by Park Chemical Co. describes the versatility, sizes and grades of their non-burning carburizing compounds.

For further information circle No. 27

DEHYDRATORS

Selas Corp. has published a bulletin describing Selas Dehydrators, designed and built to meet specific needs for effective and economical removal of moisture from most gases. Moisture removal and discharge from the system is continuous, with no flow interruption or interference. Gas inlet pressures may range from a few pounds gage to 150 psig for standard design with up to 3500 or more psig for special applications. Outlet dewpoint (moisture level) is maintained safely below the specified level, which can run to -100°F.

For further information circle No. 28

INERT GASES

C. M. Kemp Mfg. Co. has published a bulletin on "How to Make Your Own Inert Gases." Their gas generators make the gases for many purposes including atmosphere protection during heat treatment.

MECHANICAL LOADERS

Ipsen Industries, Inc. offers a bulletin describing their loaders and unloaders for use with automatic heat treating units to handle work trays either from a charging platform to proper position within the furnace or washer equipment or for withdrawing the loaded tray to a discharge platform.

For further information circle No. 29

HEAT RESISTING ALLOYS
FROM STOCK

Stock List and Literature Available

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Heat and Corrosion Resistant Alloy Specialists

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For further information circle No. 30

Temperature Range Chart

Rolled Alloys, Inc., Detroit, Michigan, has just published a 2-page, 2-color Alloy Temperature Range Chart which indicates the temperature range of various alloys and shows their usefulness as to carburizing and/or nitriding, reducing atmospheres and oxidation.

For further information circle No. 31

INDUCTION HEATING

Magnathermic Corporation has released a new 12-page booklet entitled "3 Minutes With Induction Heating." Applications such as heat treating, brazing, forging, extrusion, and metal joining are covered in the bulletin.

For further information circle No. 32

RADIANT TUBES

General Alloys has published a bulletin describing the specifications and benefits of their radiant tubes derived from their special design combining casting and fabrication.

For further information circle No. 33

ANHYDROUS AMMONIA

Hamler Industries is offering information on their complete service of anhydrous ammonia, including lending of an equipped storage tank, to the metal processing industry.

For further information circle No. 34

INDUSTRIAL BASKETS

Information is available from C. O. Jelliff Mfg. Corp. concerning their line of baskets for all industrial purposes, including heat treating, degreasing, plating, pickling and anodizing.

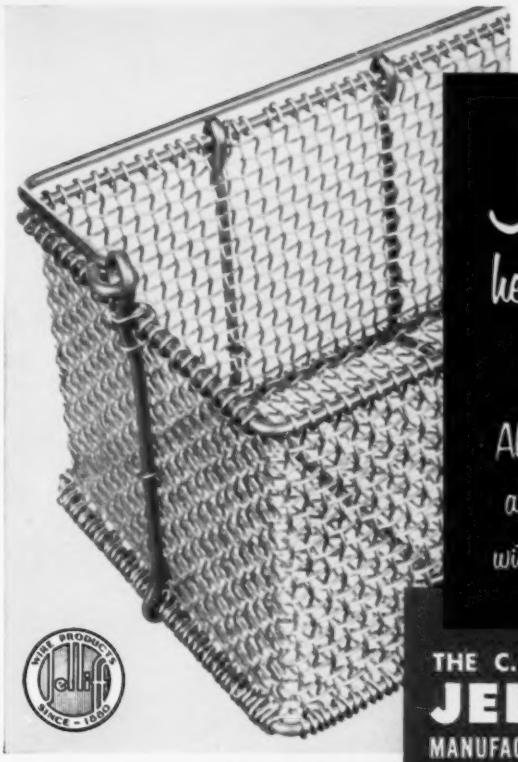
For further information circle No. 35

GAS-AIR MIXING

A bulletin published by Waukee Engineering Co. describes their Panel Mixor. It is a compressor-carburetor device for mixing gas and air in any selected ratio and compressing it for use with endothermic or exothermic cracking generators or as a source of premixed gas and air for flame heat treating and torch brazing.

For further information circle No. 36

(*Continued on page* 48)



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All shapes, sizes, alloys. Estimates without obligation.

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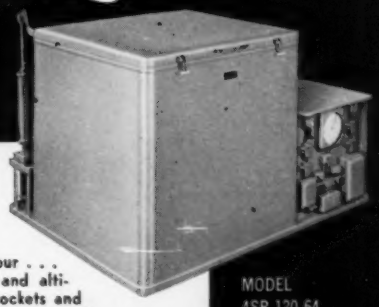

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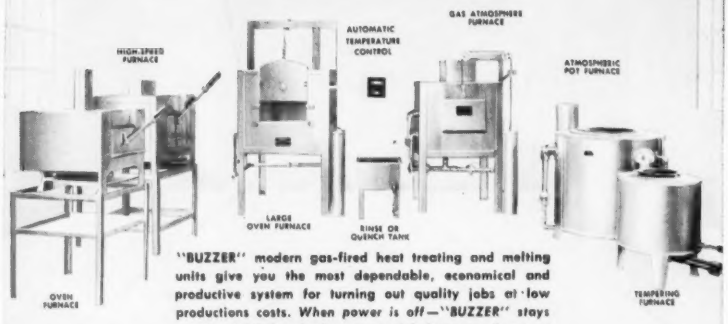
NO BLOWER OR OTHER POWER NEEDED

. . . just connect to gas supply



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LETTERS TO THE EDITOR

Gentlemen:

I am writing you concerning your magazine "Metal Treating". I would appreciate it very much if you would send me copies.

I am working for International Business Machines. I'm handling a lot of tool steels. Working for this concern for a period of time and being in such close contact with steel, I have spoken very highly of your magazine and how it helps to make better Heat Treaters.

Martin A. Monthie
Stuyvesant Falls, N.Y.

Gentlemen:

We are very much interested in seeing the article on Quenching which appeared in the January-February 1957 issue of "Metal Treating" magazine.

We would appreciate it very much if you could send us reprints of this article.

J. C. Reid
Sales Manager
Industrial Heating Equipment
Canadian General Electric Co., Ltd.
Toronto, Ontario

Gentlemen:

The following article which was reviewed in the article abstracts put out by the American Society for Metals is very interesting to us. If possible, we would appreciate your sending us tear sheets of this article for our technical file.

"Processes and Techniques for Achieving Extreme Surface Hardness & Wear Resistance," by Frank J. Rizzo.

B. A. Schwartz, Jr.
Elechem Corp.
Cleveland, Ohio

Gentlemen:

We would like to be put on the mailing list for your very fine pub-

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Specialists
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FIXTURES
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IT COSTS NO MORE!
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Designers, Builders, Fabricators of Heat Resisting Alloy and Stainless Steel Equipment
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TELEPHONE: YUKON 5-6191

lication, "Metal Treating".

A copy has circulated several times through our department and we find it to be a very useful publication. It covers heat treat metallurgy in all aspects very well.

Henry J. Tykocki, Supvr.
Heat Treat Laboratory
Aircraft Engine Div.
Ford Motor Company
Chicago, Ill.

Dear Editor:

Please put my name on your mailing list as a subscriber of "Metal Treating"—I have been reading your magazine for some time, and being in the heat treating field I find the contents very interesting and educational in every respect.

C. Rudolph Oberg
International Silver Company
Meriden, Connecticut

Dear Editor:

We shall appreciate your sending regularly to us your magazine "Metal Treating" marked for the attention of our Heat Treat Foreman.

M. J. Schrader
Chief Product Engineer
H & B American Machine Co., Inc.
Midwest Division
Indianapolis, Ind.

Dear Editor:

Congratulations on the fine article by Vincent E. Lysaght entitled "Hardness and Its Measurement" which appeared in "Metal Treating".

Our members who are producers of cast steel and cast iron rolls are very interested in the use of hardness measurements for quality control. Consequently, we should like to order fifteen copies of the article for their use.

N. R. Arant
Technical Director
Roll Manufacturers Institute
Pittsburgh, Pa.

Dear Sir:

In the capacity of foreman of the Heat Treating Department, one that produces 20,000 pounds of work daily, I would be privileged to receive your magazine "Metal Treating" because of the many exceptionally good comments I've heard from people who are fortunate enough to be receiving it.

Benjamin Sorrentino
Stratford, Conn.

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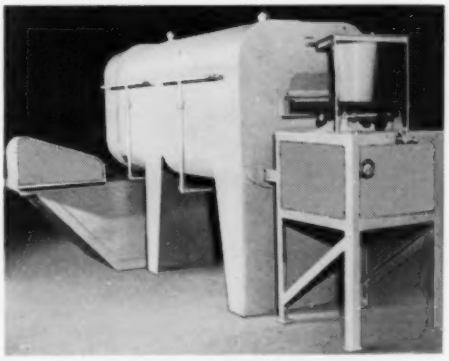
for automation in the Heat Treatment of small parts are favored for:

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Your production requirements will probably fit a STANDARD DFC SHAKER for HARDENING — NITRIDING — CARBONITRIDING — CARBURIZING

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1182	125 - 175 lbs. per hr.
1183	275 - 325 lbs. per hr.
1185	400 - 500 lbs. per hr.

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THE DENVER DFC FIRE CLAY COMPANY
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DENVER • SALT LAKE CITY • EL PASO

MANUFACTURERS' LITERATURE

(*Continued from page* 45)

MOLECULAR SIEVES

A new technical brochure on Molecular Sieves is now available from Linde Company, Division of Union Carbide Corporation. Complete information is given on using Molecular Sieves as a superior drying agent for gases. Tables and charts provide engineering data for preliminary designs of low-dewpoint drying systems.

For further information circle No. 37

FIRE HAZARDS

Randolph Laboratories has published a bulletin called "Fire Hazard Index" which lists equipment safeguards for 580 typical fire hazards.

For further information circle No. 38

PROTECTIVE ATMOSPHERE EQUIPMENT

Ammonia dissociators, for rated capacities up to 5000 CFH (and larger on special applications), which produce comparatively inexpensive hydrogen-nitrogen atmospheres of extreme purity (99.96% association) and very low dew points, are described in a bulletin issued by C. I. Hayes, Inc. of Cranston, R. I.

The bulletin also describes exothermic atmosphere generators which provide protective atmospheres of an oxidizing or medium reducing type, and endothermic atmosphere generators for providing protective atmospheres of medium or high carbon potential. These generators have rated capacities similar to those shown for the ammonia dissociator.

For further information circle No. 39

"EQUA-THERM" OVEN

A four-page bulletin describing the Aminco "Equa-Therm" Oven, a new high-temperature, high performance oven, is now available from the American Instrument Company.

The "Equa-Therm" Oven, which incorporates many new design features, produces temperatures ranging from 100° to 750°F. within a 17 cu. ft. work chamber. A table illustrating temperature differentials shows that the new oven offers point-to-point temperature differentials within limits never before obtained in commercial ovens of comparable size.

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Gas Atmospheres, Inc., Cleveland, Ohio, has just published a new bulletin describing their new self-contained packaged Nitrogen Generators. The bulletin contains illustrations of typical installations and a description of a new simplified one-station control panel.

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INDUCTION HEAT TREATING

Two bulletins published by the Tocco Division of the Ohio Crankshaft Company deal with the subject of induction hardening and heat treating. One bulletin deals with a series of case histories showing typical results and savings attained by using Tocco machines, and the other is a 20-page booklet describing their induction heating equipment.

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(*Continued from page* 5)

tant alloys, incorporate strong reducing components, thus requiring rapid heating methods or very dry atmospheres in furnace brazing.

Alloys containing elements with a strong affinity for oxygen may effect self-fluxing properties. Phosphorus in phos-copper and boron and silicon in various alloys function in this manner, provided these components through oxidation become fluid and in turn are displaced by the altered filler metal. The oxidation tendency of an alloy is not a simple average in terms of atomic ratios. In general, the cohesion or bonding forces deriving from alloying are greater than for any of the pure components so that the resultant product is correspondingly more resistant to oxidation at elevated temperatures. Recapitulating, the oxidation properties of a brazing alloy in a measure determine adaptibility to a particular method and/or base metal.

Summarizing, a brazing alloy should be calculated to produce predominantly solid solutions and perhaps insoluble aggregates in a particular type of base metal. A high degree of surface tension is generally perferred with viscosity determined by part design and method employed. Oxidizing properties cannot be fixed but along with vapor pressure should be at a minimum if the alloy is to be adaptable to a wide array of brazing conditions.

Fluxes

Research relating to fluxes must anticipate chemical and physical conditions at brazing temperatures, which will vary markedly according to the types of metals and methods involved. In many instances a particular flux may function very well but will be confined to specialized applications due to melting point, activation and fluidity characteristics. It is a bit difficult to study each aspect of the problem separately because one influences the other. For instance, the tolerable temperature differential between filler metal and flux melting points is a function of brazing time cycle, degree of metal exposure to oxidation, as well as flux activation and fluidity. Although other examples could be cited, the following demonstrate the interrelationship of flux properties and present at least some of the major considerations in developmenet work:

Example A: An easily oxidized heat resistant alloy is to be brazed with a somewhat oxidation susceptible silver solder alloy by induction heat without benefit of a protecting atmosphere. Assuming close joint clearances, the flux should be rather active, sufficient to dissolve oxides but not so excessive as to appreciably alter joint composition or solidify in interface areas, and quite fluid with a melting point substantially lower than the filler metal. The same job in a roller hearth furnace with an exceedingly dry protective atmosphere (-60°F. or lower dew point),

(*Continued on next page*)

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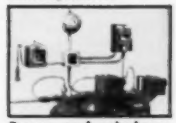

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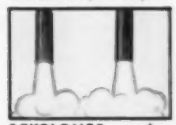

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(Continued from page 49)

would require a milder flux, with a melting point closer to that of the brazing metal, and fluidity determined by extent of penetration needed and time flux is in molten state.

Example B: A common steel or a copper-nickel part is to be furnace brazed with a low zinc-silver solder. In either case, the base metal is easily maintained in a reduced state by endothermic gas and the silver solder is only slightly more susceptible to oxidation. If endothermic gas is used in a roller hearth furnace, a mildly active (high borate-low fluorine) flux with subsequent sluggish fluidity, and a melting point sufficiently low to protect the filler metal during heating, is preferred. Alternatively, if dry dissociated ammonia is substituted, no flux or at the most a very mild borate flux would suffice.

Electrons, Protons and Neutrons

These and other infinitesimally small particles are about all our physical universe is made of, but what a fascinating and intricate interplay they afford in the universe we comprehend. About the year 1785, the great mathematician and astronomer, Marquis Pierre Simon de Laplace, was queried on the status of the universe "n" years hence. Without hesitation, he responded, "If you tell me the present positions and velocities of all the particles in the universe, and the forces acting on these particles, I shall tell you all future history." With all due respect to the brilliant de Laplace, the intervening years have steeped men of science with more humility. Since the independent development of quantum mechanics in 1924 by Werner Heisenberg and Erwin Schroedinger, much has been learned concerning the physical properties of matter. However, the theory is by no means complete, and according to some interpretations of Heisenberg's "Uncertainty Principle" probably never will be. With this in mind, consider the complexity of alloy properties deriving from the many-bodied problem of closely packed crystalline lattices. As the number of components increase, evaluating the relationship between physical forces and metallurgical properties becomes correspondingly more involved.

Our prime concern is with considerations relating to solid solution formation since this is a most significant brazing alloy property. Hume-Rothery made the important discovery that extended solid solubility is only possible where, in the case of a binary alloy, the respective atomic diameters are at no more than 15% variance. Almost total mutual solubility is not possible unless diameter disagreement is 7% or less. An equally important consideration is valency agreement, which is another way of saying solid solution formation is favored by similar periodic table grouping. Copper and nickel meet both requirements and their extended mutual solubility supports the theory. The interde-

pendency of solid solution formation upon atomic diameters and valency comparisons is illustrated by comparing the binary alloying properties of copper with zinc, gallium, germanium and arsenic.

Arsenic most nearly compares in atomic diameter to copper and if this were the only controlling factor it should have the greatest solid solubility. Experience proves that it has the least and apparently valency discrepancies are responsible. The wide disparity between copper and arsenic valencies, namely 1 and 5, is comparatively somewhat greater than atomic diameter variations in this series of elements. Therefore, considering all diameters in this group of elements equal for practical purposes, solid solution formation must depend largely on valency characteristics.

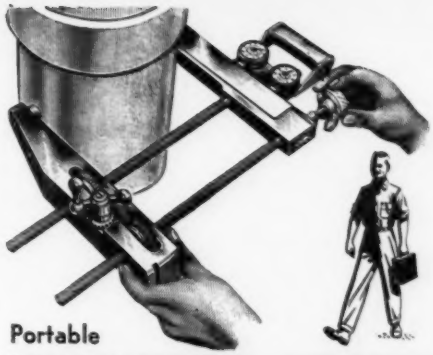
Assuming the principle of co-valency or sharing of electrons, a close approximation in these examples, two mono-valent copper atoms should combine with one atom of zinc. At the other extreme, five mono-valent copper atoms could be expected to unite with one atom of arsenic. On an atomic percentage basis then, the respective solid solubility of zinc and arsenic in copper should be 33% and 16% which closely agrees with experimental findings. The theoretical considerations relating to solid solution formation in binary alloys becomes more involved where atomic diameters disagree by approximately 15% or more and the theory is not as complete. A third factor, namely ion diameters, must then be considered; and, in general, it is more influential than valency properties.

As previously stated, intermetallic compounds are undesirable constituents in a brazed interface. This condition is most pronounced when significant valency discrepencies exist between two or more components. Viewed in another way, a combination exists between a metal comparatively more electropositive than the second component. The development of suitable brazing media and methods for titanium joining are proving difficult because the formation of these compounds is almost always encountered.

Comments of a similar nature regarding salts and flux formation would be in order but were excluded because of time and space considerations. The theory presented herein is most incomplete and can only serve to whet the appetite of the more adventuresome. Suffice it to say that the brazing field presents untold opportunities for improvements and discoveries and success will come to those who try. • • •

When Charles M. Schwab had not yet become a great man in his own right in the field of steel, he worked for Andrew Carnegie. The little Scotsman taught him one of the hard lessons of the commercial world. "All records broken yesterday," Schwab wired his chief. In reply, Carnegie telegraphed: "What have you done today?"

—Coal Heat



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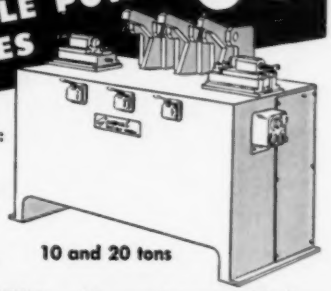

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(*Continued from page* 39)

sludge but also to bail out some of the salt bath and to add sufficient quantity of fresh salt to sweeten the bath than to risk the hazard of decarburizing the tools.

III. High Temperature Range—(1850° - 2350°F.)

B. Salt Bath Furnaces:

In isolated industries gas-fired furnaces operating within this range were used until recently. Here a carborundum cylinder, closed at the lower end, was placed in the combustion chamber, and the pot, usually pressed steel, was put into this cylinder to protect it from rapid oxidation and burning out. Heat was forced through the carborundum into the steel pot containing the salt. Under these conditions the pot lasted one, sometimes two days. This required frequent replacement of pots and repairs; occasionally one pot would burn out while hardening only one day's work. Whatever salt remained in the pot had to be quickly bailed out, and a new pot placed into the carborundum cylinder and cemented around the flange. Under such a set-up the temperature could not be controlled too closely, and this affected the uniformity and quality of the tools being processed. Such gas-fired furnaces now belong to the past.

Today, the most commonly used and accepted salt bath furnace for this range is the electrode-type with a ceramic pot. The complete furnace consists of a well-insulated shell, removable or stationary ceramic pot, electrodes, transformer and magnetic contactor. For automatic temperature control an indicating or recording instrument may be used. Often in addition to a conventional thermocouple, a sighting target or rayotube is utilized. This latter is used during actual hardening operation, and the thermocouple is used during the idling period. Since the surface radiation at high temperatures dissipates the greater portion of the electric energy supplied, (about 30 KW per square foot), the surface area should be kept to minimum but large enough to accommodate the tools to be hardened. Any portion of the pot surface not utilized may be covered with a refractory slab to reduce radiation loss and to conserve energy.

The electrode-type furnaces as manufactured in this country are fundamentally the same except for some details. In some, the pot becomes an integral part of the furnace; in others, the ceramic pot is built into a steel liner for easy replacement. In some, the electrodes are introduced from the bottom; in others, either from the side or over the top. Each method has its advantages and drawbacks.

Furnace Operation

Operation of a high temperature electrode furnace is not complicated and requires attention to a few simple details. To start, the salt has to be molten to pass the current between the electrodes. It can be melted by shorting the electrodes by a half-inch round carbon rod, by a gas torch, or by an electric starting coil which is furnished along with some furnaces.

As the salt begins to melt, the ammeter will indicate the amount of current drawn. The operator should watch to see that the rated capacity of the transformer is not exceeded for a long period of time. As soon as the rated capacity is approached, the secondary voltage tap may be changed to a lower voltage. The high temperature salt is liquid at or above 1850°F. At this temperature the pot should not be filled all the way to the top. At least 4" should be allowed for increased volume at 2250°-2300°F.

For the hardening of high speed steels, usually three furnaces are utilized; a preheat at 1500°-1650°F., a high heat at 2200°-2350°F., and a quench at 1150°-1250°F. (See Fig. 2). The preheat bath is compounded to blend with the high heat bath, and its carry-over into the high temperature bath does not create any problem. But the quench bath often is non-neutral, and any basket or fixture carried into the quench bath should be washed and dried before using in the process again.

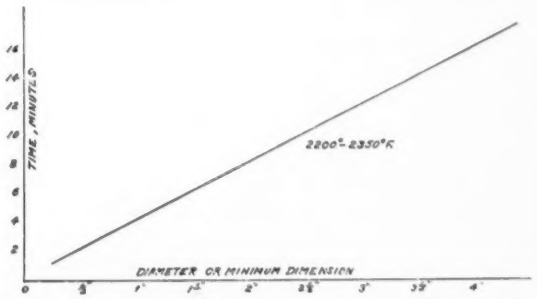

Chart #1—The relationship between the size of parts and the corresponding timing in the salt bath for the high temperature range (2200°-2350°F.)

One very important factor besides the correct temperature in the hardening of high speed steels is the correct timing. Often a tool made with the utmost care and precision and of excellent steel is ruined because of improper timing. We have seen a high speed drill ¼" round given 30 minutes in the salt bath. This excessive timing perhaps is unusual. However, either undertiming or overtiming is rather common. To avoid this possible error, and to serve as a guide, Chart No. 1 is offered.

If the tools are bunched together or handled in a basket, the time may be increased a few seconds. In timing any tool, the minimum dimension should be considered. If it is round, the diameter is the important dimension; the length doesn't matter. Two drills of the same diameter but one twice as long as the other should receive the same time. In rectangular pieces only the thickness matters; the width and the length need not be taken into account.

The timing in the preheat, although not critical, should not be overdone. Likewise, after the quench, the tools should be allowed to remain in the quench bath long enough to reach the same temperature and

then removed and cooled in the air. The salts adhering to the tools should be washed off before tempering.

Here we should mention a possible source of trouble. High speed tools carrying oil or grease will burn off the oil, leaving a carbon residue which may cause fusion on the tool. Likewise, any paint containing aluminum powder or zinc oxide unintentionally dropped on the tools may cause fusion and blistering on the tool.

The high speed steel hardening three-furnace set-up is very flexible, and lends itself, in addition to the hardening of high speed steels, to a variety of applications. These may be briefly mentioned:

(1) The preheat may be used at 1450°-1550°F. for the heat treatment of water or oil hardening steels.

(2) The high temperature furnace may be used at 1850°-1950°F. for the hardening of stainless as well as air hardening steels.

(3) The high temperature furnace may also be used at 2000°-2100°F. for copper brazing.

Conclusions

Salt baths, whether heated by gas or electricty, provide a reasonably fool-proof means for heating metals, either ferrous, non-ferrous or precious, for a multiplicity of purposes. Once installed, any person with a little instruction and a fair amount of intelligence can operate them safely and satisfactorily. They do not require a highly-skilled operator nor long periods of apprenticeship. There are a number of manufacturers with many years of experience who are available to furnish information and guidance regarding any application utilizing salt baths and salt bath furnaces.

Finally, they offer the following advantages:

(1) Freedom from oxidation or scaling.
(2) Uniform heating.
(3) Precise control of temperature.
(4) Minimizing of distortion.
(5) Faster heating and more production.
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Two partners were arguing as to what they should do to increase business in their theater. One contended that more people would patronize the house if the seats were recovered with red leather; the other thought mohair more appropriate. Unable to reach a decision, they appealed to a third partner, who had stood by saying nothing.
"What do you think about it, Joe?"
"I think we should cut the admission price and cover the seats with people."

—The Virginia Standard

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Philadelphia 33, Pennsylvania

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SINCLAIR REFINING COMPANY
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New York, New York

SUN OIL COMPANY
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Philadelphia 3, Pennsylvania

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NITROGEN DIVISION
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New York 6, New York

NORTON COMPANY
Worcester 6, Massachusetts

SALTS (Heat Treating)

ALLIED CHEMICAL AND DYE CORP.
NITROGEN DIVISION
40 Rector Street
New York 6, New York

AMERICAN CYANAMID COMPANY
METAL CHEMICALS SECTION
30 Rockefeller Plaza
New York 20, New York

HEATBATH CORPORATION
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Springfield 1, Massachusetts

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CINCINNATI SUB-ZERO PRODUCTS COMPANY
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MAGNAFLUX CORPORATION
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TESTING SERVICES

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Following exhaustive tests, Stanwood offers the new Cor-Wall construction Stacking Baskets. Sides of this heat resistant alloy basket are corrugated rolled metal, imparting a longer service life, greater load carrying ability and lighter weight. Bottom grid, grid supporting base ring and stacking ring at top are high temperature cast alloy. Use Stanwood's broad experience and modern facilities for your heat treating equipment — baskets, trays, fixtures, retorts, pots, carburizing boxes and furnace parts. Send for catalog. Stanwood Corporation, 4825 West Cortland Street, Chicago 39, Illinois.

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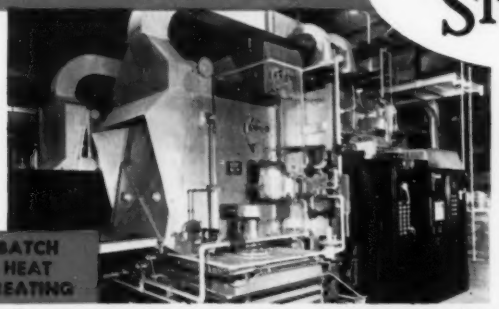
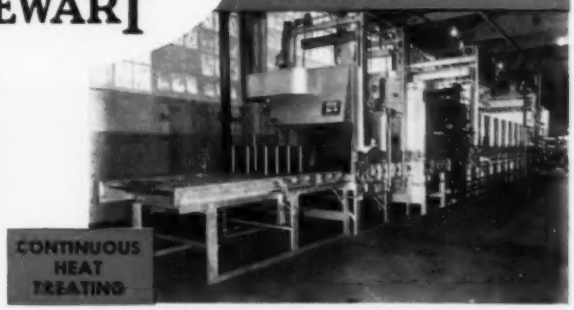


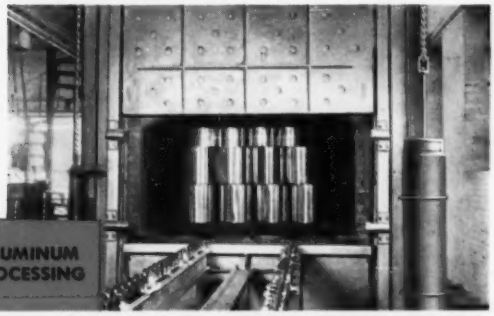
BATCH HEAT TREATING

Furnaces for batch annealing, drawing, brazing, hardening, ageing, nitriding, cyaniding, preheating, carburizing, carbonitriding, normalizing, forging, solution treatment and tempering. (Atmosphere type or direct fired.)



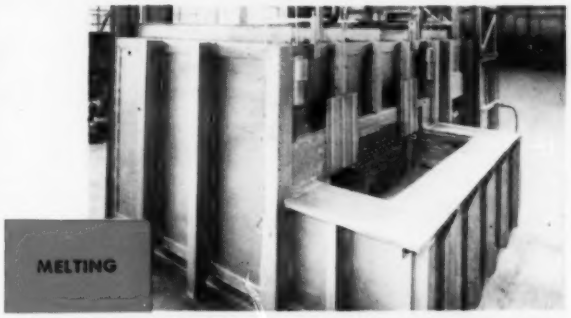
CONTINUOUS HEAT TREATING

Furnaces for continuous annealing, drawing, brazing, hardening, ageing, normalizing, forging, carburizing, solution treatment, tempering, carbonitriding. Automatic or manual handling. Designs based on sound engineering, actual installations.



ALUMINUM PROCESSING

Furnaces for annealing, heating, solution heat treating, homogenizing, brazing and melting. Batch or continuous types for any shape or alloy. (Controlled atmosphere, direct-fired or convection heated.)



MELTING

Furnaces for melting and holding aluminum, copper, brass, magnesium, tin, zinc, babbit and lead. Stationary or tilting. For all types of foundries, die casting, sand casting and permanent mold plants.

WIRE AND STRIP PROCESSING

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- **Complete Design—Engineering—Construction—Start-Up Service**
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**Visit us at the Southwestern Metal Show,
State Fair Park, Dallas, Texas,
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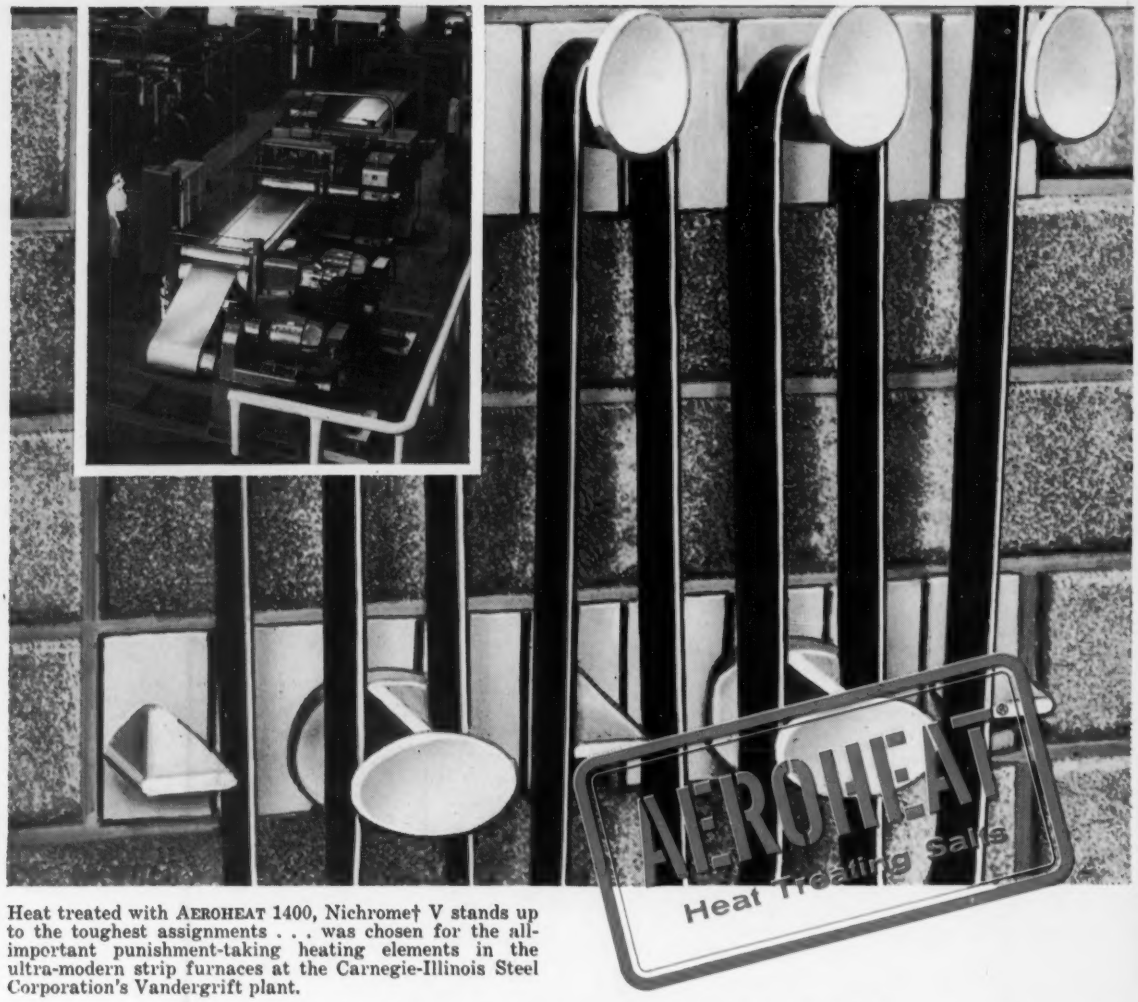
Sunbeam CORPORATION (Industrial Furnace Division)
Dept. 257, 4433 Odgen Avenue, Chicago 23, Illinois



Heat treated with AEROHEAT 1400, Nichrome† V stands up to the toughest assignments . . . was chosen for the all-important punishment-taking heating elements in the ultra-modern strip furnaces at the Carnegie-Illinois Steel Corporation's Vandergrift plant.

WHY DRIVER-HARRIS HEATING ELEMENTS RATE WORLD'S TOUGHEST ASSIGNMENTS

The leading manufacturer of electric heating and resistance alloys, Driver-Harris Company of Harrison, New Jersey, knows the vital importance of selecting the right heat treating compound. That's why the company chooses from Cyanamid's comprehensive range of AEROHEAT compounds to give each alloy its particular characteristics.

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You too can upgrade your products, lower your costs with AEROHEAT Heat Treating compounds. For details, just call your Cyanamid Metal Chemicals representative.

Cyanamid's heat treating compounds include:

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- AEROCASE® Case Hardening Compounds
- AEROHEAT Heat Treating Salts

Other products for metal processing include:

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- AERO* Metallic Stearates
- AEROMET® Metallurgical Additive
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American Cyanamid Company, Metal Chemicals Section, 30 Rockefeller Plaza, New York 20, New York. In Canada: North American Cyanamid Limited, Toronto and Montreal

† T.M. Driver-Harris Co.

* T.M. Cyanamid

METAL CHEMICALS SECTION

CYANAMID